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ABSTRACT

A category system consisting of 36 categories was developed for classifying the verbal behavior of each pupil in high school biology lecture-discussion classes. Two classes each of eight high school biology teachers were observed and tape recorded for four consecutive days. Classroom interaction was coded combining a teacher-behavior category system with the pupil behavior system. The data were organized into interaction matrices, and frequencies of different modes of pupil participation were calculated. Behavior sequences were studied, and common cyclical patterns were identified. It was found that in the average classroom two pupils accounted for about 25% of pupil talk, four pupils for about 50% and eight pupils for about 75%. Pupil characteristics significantly related to participation were sex and previous achievement. Not related were intelligence (measured by Lorge Thorndike and California Test of Mental Maturity), School and College Aptitude Test scores, and attitude toward teacher, subject and class (measured by the Michigan Student Questionnaire). Final achievement in biology (measured by the New York Regents Examination and the teacher's final grade) was positively correlated with participation. (EB)

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A STUDY OF RELATIONSHIPS AMONG TEACHER BEHAVIOR, PUPIL BEHAVIOR, AND PUPIL CHARACTERISTICS IN HIGH SCHOOL BIOLOGY CLASSES

SEPTEMBER 1967

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Jal S. Parakh

September 1967

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Western Washington State College

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CHAPTER I

INTRODUCTION

Background and Problem

Most of the research on teaching has been conducted in the area of teacher effectiveness. Yet more than a thousand studies in over half a century of teacher-effectiveness-research have failed to provide definitive answers to the questions: "What is good teaching?" and "What are the characteristics of a good teacher?"

Within the last fifteen years there has been a significant change from research on characteristics of teachers and the evaluation of teaching to the systematic observation and description of teaching. Largely due to the efforts of researchers like Flanders, Amidon, Smith, Bellack, Gallagher and others, research on classroom behavior of teachers and pupils, based on first hand systematic observation has now been established as an important field of study and a rich armamentarium of observational techniques and classification systems or category systems has been developed.

However, primarily due to restricted theoretical conceptualization and methodological complexities, most of the current research on teacher-pupil interaction has been directed toward the detailed classification and description of the verbal behavior of teachers. Considerably less attention has been devoted to the detailed classification and description of pupil behavior. Furthermore, even in those cases where pupil behavior has been classified and described in any detail, the descriptions are given in terms of the entire class of pupils as an undifferentiated group. Thus, the verbal behavior or utterances of one pupil or a small number of pupils is attributed to the entire class. Classroom observers typically report that "Pupil-Talk" accounts for about 25% of the time spent in classroom discourse. Such reports do not tell the reader whether all the pupils or only a small number of the pupils participated nor do they indicate the different degrees and kinds of participation by individual pupils.

Hence, despite frequent pronouncements about the individuality and uniqueness of each learner, systematic quantitative descriptions of the behaviors of individual pupils engaged in classroom activities are particularly limited. In order to provide a fuller description and to arrive at a deeper understanding of teacher-pupil interaction a number of interesting and important questions need to be investigated-- for example: Is the verbal interaction between the teacher and pupils more or less evenly distributed or is it predominantly between the teacher and a handful, say about one-fifth, of the class? Do those pupils who ask the most questions also give most of the answers? What is the relationship, if any, between quantity of participation and quality of participation? What are the characteristics of pupils who participate the most, or the least? Do teachers ask certain pupils more of certain kinds of questions? Do teachers who ask questions requiring higher levels of intellectual operations influence their pupils to ask similar questions?

The foregoing and many other questions have perplexed the writer -- and doubtless others -- while engaged in a systematic study of teacher-pupil interaction in high school biology classes (29). Teacher-pupil interaction is so bewilderingly complex that researchers, including the writer, have to "take one thing at a time". To raise these questions is not to deprecate prior research but to emphasize that the study of teacher-pupil interaction is still in its infancy. The harsh fact is that we have not developed systematic observational techniques that will yield reliable quantitative data not only in terms of which pupils participated and how much but also what kinds of questions were asked by each pupil, what kinds of responses were given by individual pupils, and so on. Clearly, at least at the elementary and secondary levels, while teachers talk and interact with the class as a whole, they also (perhaps more often) interact with individual pupils. Researchers studying teacher-pupil interaction can ill afford to neglect this fact of classroom life even though it places an almost impossible burden on the present methodological and conceptual sophistication -- or lack of sophistication.

Sound conceptualization of science teaching, or teaching any other subject, must be built on a solid foundation of objective, quantitative, empirical findings. Without deprecating the prodigious efforts to improve science teaching in our schools -- the developement of new courses and materials, the institutes for training teachers and the writings in the literature about the teaching of science as inquiry are well known -- one is forced to acknowledge that much less effort has been put into furthering our basic understanding of the incredibly complex process of teaching. We must systematically study and analyze just what it is that teachers and individual pupils say and do as teachers teach and pupils learn. In behavioral terms just what is the "inquiry approach" or "discovery approach" or "conventional approach". As Watson (43) in a review of recent research and developments in Science Education cogently stated: "Research on the relations between behavior of science teachers and other variables such as behaviors of their pupils is meager.... Without clear, empirical evidence of what sorts of experiences result in what subsequent behaviors or enhanced behaviors, in pupils, we are of necessity proceeding on faith."

The present study is another step in a series devoted to the description and conceptualization of science teaching. An earlier study by the writer (29) resulted in the developement of a category system for the analysis of teacher-pupil interaction in high school biology classes. The emphasis in the earlier study was on the classification of teacher behavior and description of interaction in terms of teacher and the whole class of pupils. The emphasis in this study is on verbal classroom behavior of individual pupils.

In sum, the primary purpose of this research is instrument development and the classification, quantitative description and analysis of individual and collective verbal behavior of pupils in high school biology classes. A secondary purpose, viewed as an exploratory phase at present, is to study certain relationships: (a) between teacher behaviors and pupil behaviors; (b) between pupil behaviors and pupil characteristics; (c) among various pupil behaviors; (d) between pupil behaviors and pupil achievement.

Rationale

Many reviewers and researchers (22, 26, 31, 32, 43) have pointed out that in much of the research on teaching the researchers have studied the antecedents and consequences of whatever it is that happens in classrooms. Hence, a striking gap exists in our knowledge of teaching per se. Within the last ten years a few highly significant studies have been directed by Flanders (11, 14), Amidon (1, 3), Smith (37), Bellack (8), Gallagher (15, 16) and a number of objective, quantitative descriptions of teacher-pupil interaction have been published. However until very recently much of the research in teacher-pupil interaction has been conducted in elementary and junior high schools and in subject matter areas other than science. Within the past two years a number of researchers (21, 24, 25, 28, 39, 42) have used the Flanders System of Interaction Analysis (2, 14) to quantitatively describe classroom behavior of secondary school science teachers and to a lesser extent the behavior of pupils in science classes. These descriptions of teacher-pupil interaction in science classes have been in terms of the relativeely global (rather than specific) categories of the Flanders System and within the framework of Direct-Indirect Teacher Influence formulated by Flanders (10, 13, 14). Researchers interested in appropriate theoretical models and techniques of systematic observation of teachers and pupils in science classes need to develop other conceptual models and techniques and/or modify existing ones. As Smith (38) remarks: "There are many forms of interaction involving all sorts of processes and content...(the researcher) will soon discover that the actions and reactions of students and teachers are in considerable measure determined by the requirements of the subject matter."

The writer (among others) views teaching as a specific case of social interaction directed primarily toward the achievement of educational objectives. To a large extent, the teacher influences, structures and directs the specific interactions. The teacher exercises control not only on the kinds of information he presents and the kinds of questions he asks -- such as requiring recall of facts versus explanation of phenomena and prediction of consequences -- but also on the kinds of questions, answers and voluntary contributions he encourages, discourages or permits from individual pupils or the class as a whole. However, while the teacher is postulated as the major determinant of pupil classroom behavior, the pupil's characteristics such as ability, attitudes, personality, needs, sex, etc. are also postulated as influencing the pupil's behavior in highly specific though as yet largely unknown ways.

In an earlier study, the writer (29) found that the kinds of quasi-logical operations used most frequently by pupils in the classroom were largely determined by the teacher's questions. In effect, the teacher asked for definitions, facts, and explanations and the pupils generally though not always gave the corresponding responses. The teacher usually asked "relatively long, structured questions when he solicited definitions and explanations so that the pupil merely supplied the 'missing word(s) in a sort of verbal game of filling in the blanks'". The above study focused primarily on teacher behavior and hence no information is available regarding questions such as: did only a few of the pupils play the verbal game of filling in the blanks? What were some of the characteristics of the pupils who played the game and of those who did not? Does a teacher's propensity for asking predominantly factual versus say explanatory questions "rub off" on the pupils? If so, how is such specific imitative behavior related to pupil variables such as sex, ability level, certain personality traits? While the teacher is often said to be a "model" our present state of knowledge, based largely on paper and pencil tests, is not sufficient to answer such highly specific questions about on-going classroom behavior of pupils. It is hoped that the present exploratory study will provide some of the specific, albeit tentative, answers and provide guidance for more rigorously controlled research in the near future.

A number of assumptions have been made more or less explicitly in the statement of the rationale for this research. Without further comment the major assumptions underlying this study are given below:

1. First-hand systematic observation of classroom interaction and the individual behavior of teachers and pupils is the most direct and fruitful way of finding out what teachers do as they teach and what pupils do as they receive instruction.
2. Systematic observation and analysis of individual and interactive classroom behavior can provide a sound empirical base on which a theory of the classroom behavior of teachers and pupils can be constructed.
3. The classroom behavior of teachers and pupils is multi-determined -- situational factors such as the learning environment and the course of study, and certain characteristics of the participants are major determinants.
4. The teacher's behavior largely determines the affective and intellectual climate of the classroom.
5. The major portion of the classroom behavior of teachers and pupils is directed towards the achievement of educational objectives.
6. The total observed classroom behavior can be classified into smaller (elemental) units and quantified reliably.
7. Certain sequences and combinations of units or patterns of behavior can be observed to occur more frequently than others.

8. Knowledge of the relative frequency of occurrence of various units and combinations of units of behaviors can lead to understanding and prediction of classroom behavior and ultimately learning outcomes.

9. The verbal behavior of pupils and teachers is an adequate sample of total behavior in lecture-discussion-recitation classes.

10. The observation and tape-recording procedures to be used in this study will, compared to other factors, have a relatively minor affect on the classroom behavior and hence will not result in significantly atypical behavior.

11. A sufficiently large sample of classroom behavior can be observed and recorded so as to be representative of total behavior.

Related Research

Among the earliest attempts to measure classroom behavior were the schemes developed by Horn in 1914 and Puckett in 1928. In Horn's scheme (19) the observer used a seating chart and drew a small circle in the appropriate block for "each recitation or request for recitation and a square for each time a pupil responds by doing something". Thus Horn's scheme could depict each pupil's participation as well as the overall distribution of pupil participation.

Puckett (30) extended Horn's scheme by introducing a variety of symbols to represent various kinds of pupil behavior, such as: Pupil raised hand . , pupil raised hand and was called on by teacher ⊙ , pupil called on when hand was not raised ◻ , pupil asked a question> etc. In addition to describing pupil behavior Puckett also evaluated the pupil's statements as single-word ⊙ or ◻ , fair ⊙- or ◻- , good ⊙ or ◻ , and very good -⊙ or -◻ . A major shortcoming of Puckett's scheme was that description and evaluation were telescoped. Medley and Mitzell (26) in recommending this ingenious scheme state that "the plan could be used today, adapted perhaps, to some other system for classifying pupil contributions to class discussion than the simple quality rating proposed."

Numerous rating scales have been developed since the earliest attempts by Horn and Puckett. By definition, rating scales are evaluative and not descriptive category systems for systematic observation and description. A review of rating scales is therefore outside the scope of this study. The reader will find a review of rating scales in Gage (17).

The earliest systematic observational studies of classroom interaction began with the work of Thomas (41) followed by Anderson (5), Lewin et al (23) and Withall (45,46). These workers introduced techniques and concepts from the fields of child study and social psychology to the study of child-teacher interaction. Thomas and Associates (41) made a major contribution by making a break from evaluative rating scales and set a high standard of accuracy and objectivity. The studies by Anderson (5), Lewin et al (23), Anderson et al (6), and Withall (45, 46), dramatically showed that the affective climate of the classroom is largely influenced, if not determined, by the teacher's behavior, and stimulated a great deal of interest in systematic observation and objective quantitative description of classroom behavior. Descriptive terms such as dominative, integrative (5), democratic, laissez-faire, authoritarian (23), learner-centered, neutral and teacher-centered (Withall 45, 46), were used to describe the bahvior of teachers and teacher-surrogates. Indices such as the "Integrative-Dominative Index" (5,6) and Social-Emotional Climate (45, 46) were used to describe the affective climate of the classroom.

Flanders (10) greatly influenced by the work of Anderson (5), Lewin et al (23) and Withall (45) studied the effect of direct and indirect teacher influence on attitudes and achievement of pupils. To classify the verbal interaction of teachers and pupils in classrooms, Flanders developed a system of ten categories -- seven for teacher-talk, two for pupil-talk and one for silence and confusion. In addition Flanders developed an ingenious technique of interaction analysis whereby the classroom behavior is coded at three second intervals into one of the ten categories. The category numbers are written so as to preserve the original sequence of numbers. These numbers are then entered into an interaction matrix. Different cells and areas of the matrix represent different behavioral sequences which can be studied to determine patterns of teacher influence and collective pupil behavior -- but not individual pupil behavior.

The Flanders category system and his technique of interaction-matrix-analysis (Flanders 10, 11, 12, 13, 14) has become increasingly popular, probably due to the relative ease with which it can be used. However, in the view of the writer and other investigators, the Flanders system has various shortcomings especially for the study of science classes. First, the fundamental assumption underlying the Flanders system, that the verbal behavior of the teacher is an adequate sample of his total behavior, needs to be qualified. Parakh (29) questioned this assumption and found that the pedagogically relevant non-verbal behavior of the teacher constituted 3 to 13% and 21 to 56% of the total classroom behavior in lecture-discussion-recitation classes and laboratory classes respectively. Second, Flanders' system is predominantly oriented toward classifying and describing the affective or social-emotional aspects of classroom behavior. The cognitive aspects are classified into two global categories... "teacher asks questions" and "teacher lectures"... even though cognitive transactions usually account for three-fourths or more of the total behavior.

Smith (36) persuasively advocated a shift in emphasis from the affective to the cognitive aspects of classroom behavior. Smith (36) points out that "...it is well to remember that teaching consists not only in ways of relating to students but also in ways of dealing with the content of instruction... What specifically are the operations by which information is given? What are the cognitive structures involved in receiving information?"

Following Smith's lead (35,36), theoretical conceptions of the relationships of language and meaning, language and thought developed by philosophers, logicians and phychologists have been adapted by groups of workers at The University of Illinois (7, 15, 37) and at Columbia University (8).

Smith, Meux and Associates (37) have developed an extremely detailed classification system consisting of about 35 categories of the "logical operations" of teaching such as defining, designating, explaining (about five kinds of each), classifying, etc. Aschner (7) and Gallagher (15) have adapted Guilford's "Structure of Intellect" model (18) and focused on the verbal responses of gifted students to infer and classify thought processes. The five major categories (with many sub-divisions) are: cognitive-memory, convergent-thinking, divergent-thinking, evaluative thinking, and routine. Bellack et al (8) classified the classroom discourse into four "pegagogical moves", namely; soliciting, structuring, responding and reacting. They also simplified Smith's 35 categories of logical operations by collapsing them to seven.

Two important distinctions can be made between the above mentioned work of Flanders (10, 11, 12, 13, 14) and Amidon (13) on the one hand and the work of Smith et al (37), Aschner (7), Gallagher (15), and Bellack (8). First, the former group has placed emphasis on the affective aspects and the latter group has emphasized the logical and cognitive aspects of classroom discourse. Second, the small number of relatively global or general categories of the former group permit easy and reliable coding of verbal interaction either on-the-spot or from tapes; while the large number of specific, finely discriminating categories of the latter group necessitate the transcribing of tape recordings and analysis of verbatim typescripts by teams of judges or observers. Moreover, the great advantage of matrix analysis has not been utilized by the latter group.

Parakh (29) drawing on previous work developed a category system which classified the affective, cognitive, and procedural or routine aspects of classroom behavior as well as the pedagogically relevant non-verbal behavior of teachers. Using a framework of communication theory and social-interaction theory he developed a system of 45 categories (16 major categories, 28 sub-categories and a residual category) which could be used for categorizing on-the-spot in the classroom or from tapes or typescripts. By postulating a general isomorphism of teacher and pupil behavior a multiplicative effect was realized so that the observer needed to learn only a handful of categories rather than 45 distinct categories. For instance, the four categories of logical operations, defining, fact-stating, explaining and evaluating are multiplied into sixteen by distinguishing (a) two sources of behavior -- teacher and pupil; (b) two modes of communication -- information-giving and information-seeking. It should be added that high inter-observer reliabilities, about 0.7 to 0.9, were achieved for on-the-spot coding. The data were tallied into matrices of different sizes (16 x 16, 31 x 31, 44 x 44) and analyzed at different levels of detail. Thus the advantages and strengths of prior systems and schemes were maximized and many of the shortcomings minimized. However, a major shortcoming still remained to be overcome; namely, the lack of systematic, detailed description of each pupil's participation and interaction.

In the somewhat chronological review of the literature the writer has focused primarily on delineating the trends in the study of classroom behavior commencing with description and subjective rating of pupil behavior, followed by decades of attempts to evaluate teacher effectiveness, to the present emphasis on systematic, objective study of classroom behavior -- predominantly the verbal behavior of teachers. Only those studies which have contributed quite directly to the writer's thinking and research have been mentioned. A more general recent review is one by Amidon and Simon (4). The reader may wonder about the relative absence of studies related to classroom behavior of teachers and pupils in science classes or of studies specifically related to the behavior of individual pupils. Two reasons can be given: (1) there are very few such studies and (2) those studies that have been conducted have a less direct bearing on the present study. Hence certain studies will be mentioned briefly and the findings most relevant to the rationale and procedure of this study will be abstracted.

In ninth grade English and Reading classes, Drews (9) studied the interrelationships among student abilities, characteristics, ability-level grouping patterns and classroom interaction. In addition to paper and pencil tests and rating scales, the classroom discourse was tape-recorded and observers were used to note the order of specific student and teacher contributions in class discussions. Observer records, entered on seating charts were used in attributing pupil contributions to individual contributors. Eight tapescripts -- two each from superior, average and slow homogenous groups and two from heterogenous classes -- were coded in terms of (a) words used above fourth grade level (b) average number of words per sentence and per contribution. Comparison of contributions by superior and slow students in homogenous and heterogenous groups showed that in the homogenous classroom the superior and slow students talked an average of 3.44 and 4.03 times per class. In heterogenous classes "...the superior students recited an average of 7.77 times per class whereas the slow students made but an average of 0.86 contributions" (9).

Gallagher (15) compared high-achieving, gifted, secondary school boys on measures of cognitive thinking (based on Guilford's model), classroom expressiveness, self-concept and attitudes. He found that the boys were significantly more expressive on all classroom variables. However on written tests of similar abilities there were no significant differences and the girls actually scored higher on giving solutions to hypothetical problems.

In a more recent study, Gallagher (16) found that high-expressive boys scored significantly higher on a written biology test (BSCS) than non-expressive boys. A similar (though statistically not significant) difference was found in favor of the high-expressive girls.

Kleinman (20) found that junior high school teachers who were rated high on asking of critical-thinking questions asked significantly fewer "lower-type questions". The writer wonders whether a similar relationship exists among types of questions asked by pupils.

Taba (40) analyzed typescripts prepared from tape-recordings in elementary classes and found the number of pupils participating in class discussion ranged from 33 percent in one class to 100 percent in another, with a mean of 76 percent across 20 classrooms encompassing 481 pupils. Taba further found that those pupils who produced the most "thought units" produced the most higher levels of thought. It remains to be seen whether a similar relationship will also be found at the tenth grade level in biology.

Matthews (24) and McLeod (25) using the Flanders system in a study of the influence of the supervising teacher on the student-teacher found that student-teachers became more like their cooperating teachers in certain verbal behaviors but not in others. Again, the writer wonders whether the high school students' questions reflect the predominant logical operations used by the teacher and whether the "modeling" (if any) is mediated by personality factors, ability levels, sex, etc.

Objectives

The objectives of this study are:

1. To develop an observational technique and a category system for classification, quantitative description, and analysis of the verbal behavior of individual pupils in high school biology classes. (This category system will be an adjunct to the Parakh teacher-pupil interaction analysis system developed in a previous study based primarily on teacher behavior and collective pupil behavior).
2. To determine reliability of the "Verbal Pupil-Behavior Category System" (VPBCS).
3. To use the Verbal Pupil-Behavior Category System for on-the-spot, systematic, observation and categorization of verbal behavior of each pupil in homogenously and heterogenously grouped biology classes and to describe and analyze the observed behavior.
4. To classify and describe the teacher-pupil interaction in homogenously and heterogenously grouped biology classes.
5. To conduct a preliminary exploration of ralationships suggested by the rationale of the study,
    a) Between various categories of teacher behaviors and various categories of pupil behavior in classrooms.
    b) Between various categories of pupil behavior in classrooms and pupil characteristics such as IQ, sex, attitudes, general scholastic ability.
    c) Among various categories of pupil behavior in classrooms.
    d) Between various categories of pupil behavior in classrooms and pupil achievement.
6. To contribute towards (a) improved conceptualization of teacher-pupil interaction (b) pre-service and in-service training of teachers of science and possibly other subjects.
7. To add to the store of tape-recorded classroom behavior of teachers and pupils in high school biology classes for future use in interaction analysis and teacher training.

CHAPTER II

METHOD

This study was programmed in three slightly overlapping phases. Phase one was directed toward reaching objectives one and two, i.e., the formulation of detailed categories of verbal pupil-behavior, the development of the observational technique, and determination of reliability of the Verbal Pupil-Behavior Category System. Phase two consisted of field work or visitation and observation of high school biology classes and was directed to partial attainment of objective three, i.e., on-the-spot coding of the verbal behavior of each pupil. Phase three was devoted to coding teacher-pupil interaction from audio-tapes, data-processing, analysis and reporting, i.e., meeting all the objectives not met in phases one and two.

Formulation of Categories of Verbal-Behavior of Pupils

In an earlier study the writer (29) had developed a system for the classification of teacher-pupil interaction consisting of forty-five categories (see Appendix A). Pupils' verbal behavior was subdivided into two major categories, Pupil Asks for Substantive Information and Assistance, category fourteen, and Pupil Gives Information or Responds, category fifteen. These major categories, representing two ways or modes of pupil-talk, were subdivided into six and eight sub-categories respectively. On the basis of careful observation of pupil behavior in biology classes, study of the literature and reflection the writer concluded that when viewed from the perspective of the degree of inititiave or independence or autonomy used, the major category -- Pupil Gives Information or Responds -- actually consisted of three distinguishable ways or modes of giving information, namely, pupils giving information by using their own initiative, pupils giving information or responding voluntarily, i.e., when a question or direction was addressed to the class as a whole or to no one pupil in particular and pupils giving information or replying when specifically addressed or called upon by name or a gesture such as pointing or nodding of the head. These three ways or modes of information-giving by pupils were labelled as Self-Initiated Information Giving (S), Volunteering (V), and Replying upon Specific Request or Direction (R).

The four modes of pupil-talk -- Asking Questions (Q), Self-Initiated Information-Giving (S), Volunteering (V) and Replying (R) were further subdivided according to nine kinds of utterances identified in a previous study by the writer (29). These nine kinds of utterances were: Defining (D), Fact-Stating (F), Explaining (X), Evaluating (E), Explicitly referring to the Nature of Science (N), Stating Lack of Knowledge or Information (L), Verbalizing Problem-Solving Procedures (P), Dealing with Classroom Routines (R), and

Utterances Unclassifiable in the above eight kinds (U). Detailed definitions of these kinds of utterances are given in Appendix A.

By combining four modes of verbal pupil-participation with nine kinds of utterances a total 36 mutually exclusive categories were formulated as described in detail in Appendix B. Each category name was symbolized by a combination of two letters of the alphabet, the first letter referring to one of the four modes of participation (Q, S, V, R) and the second letter referring to one of the nine kinds of utterances (D, F, X, E, N, L, P, R, U) as follows:

QD, QF, QX, QE, QN, QL, QP, QR, QU
SD, SF, SX, SE, SN, SL, SP, SR, SU
VD, VF, VX, VE, VN, VL, VP, VR, VU
RD, RF, RX, RE, RN, RL, RP, RR, RU

Technique for Observation and Coding of Verbal-Behavior of Pupils

Location of Observer

Probably the best position for observing the verbal behavior of pupils would be the "front" of the class i.e., facing the pupils. However, (as expected) the presence of an observer in front of the room making notations was distracting to both the teacher and pupils and so the observer sat on one side or the rear of the classroom in such a way as to get a side view of the faces of as many pupils as possible and to hear what was said. (The replies of teachers and pupils to a questionnaire indicated that the observer's presence resulted in little or no interference in the classroom discussions.)

Observation Record

In order to obtain a record of the verbal behavior of individual pupils, seating charts with names of pupils were prepared in advance for the class being observed and the verbal behavior of each pupil was coded, in the appropriate block of the seating chart, as it occurred during the entire class period. In addition, the sequence of utterances was also preserved by using numerical subscripts along with the two letter symbol for the category of behavior observed. For example, the code VX_5 in a particular seating block would indicate that the pupil had volunteered an explanation and that this was the fifth pupil-utterance during that class period. Thus the observational record at the end of a period would consist of a number of category symbols in various blocks or seating spaces of the seating chart as shown in Appendix Table B-1.

Some Methodological Issues

Various units of behavior may be used for quantification, such as, an act, a word, a sentence, and so on. Such units are usually called natural units to distinguish them from arbitrary units such as a typewritten line or page, or a time unit of a certain number of seconds or minutes. From observation, the writer found that pupils usually asked one question when they "had the floor" or responded with a word, a phrase and sometimes with a complete sentence but rarely gave long responses involving a variety of utterances. Thus pupils typically gave single facts, definitions, brief or partial explanations lasting five seconds or less rather than a number of facts, definitions etc. Thus it was decided that each instance when a pupil spoke and used one mode and one kind of utterance, i.e., a single category, it would be counted or tallied as a single behavioral event. If a pupil used more than one category, i.e., more than one of the four modes or used more than one of the nine kinds of utterances while he or she was speaking then each shift in category of speech was tallied. Thus the notations VF_{31} QX_{32} would signify that the pupil had volunteered a fact and then asked for an explanation. In order to keep a record of the few instances when a particular utterance lasted more than five seconds the observer simply jotted down the same category number and subscript once every five seconds and then drew a line or bar over the notations. Thus, $\overline{VX_{12}VX_{12}VX}_{12}$ would signify that the pupil volunteered an explanation that lasted about fifteen seconds.

Two problems in attributing behavior to the speaker arose when the observer heard a pupil speak or whisper but could not locate the speaker or when a group or more than two pupils spoke at the same time. Such utterances were noted on the bottom of the seating chart in two spaces marked "unidentifiable speaker" and "group" respectively.

Reliability of the Verbal Pupil-Behavior Category System

An important feature of a category system is that it enables an observer to obtain objective information. Thus two or more observers categorizing the behavior in a given classroom at the same time can obtain essentially the same data by following the "rules" of the observational system. The term reliability has a number of meanings and is used in this section to indicate inter-observer agreement. A percentage of agreement was calculated based on the formula developed by Osgood, Saporta and Nunnally (27).

A graduate student in Science Education was trained by the writer. Upon completion of training the writer and the trained observer sat at opposite corners at the rear of a classroom and independently coded the pupil participation for two biology lecture-recitation-discussion periods per day for four days. There were fourteen students in one biology class and twenty-three in the other. Both classes were taught by the same teacher.

Percentage agreement was calculated on scores for total pupil-talk and the four modes of participation. The percent agreement on total participation scores ranged from 50 to 100%, the median percent agreement was 77% in the class of 23 students and 88% in the class of 14 students. Detailed results of reliability tests are given in Appendix Tables B-2 and B-3.

The generally high level (percentage) of agreement reached between the writer and the trained observer constituted evidence that the observational technique and categories could be used for the research purposes of this study.

Observation of High School Biology Classes

Sample

About 390 biology students in sixteen classes and eight biology teachers from three fairly large schools in central New York State were selected. Two lecture-recitation-discussion classes of each teacher were observed in the Spring (April and May) of 1966 for four consecutive days after an initial acclimatization visit. It was assumed that four days of observation would yield stable, representative data regarding classroom behavior.

Pertinent information regarding various characteristics of the eight teachers and information about the three cooperating schools are presented in Table 1. Characteristics and achievement scores of the sixteen classes of pupils are presented in Table 2. The teachers and classes are referred to by a two-digit number instead of name to protect their anonymity. The first number represents the teacher and the second number indicates the class, e.g., 11 and 12 refer to teacher one - class one, and teacher one - class two respectively.

As shown in Table 1, the teachers' ages ranged from 25 to 40 years. Seven out of the eight teachers were males. The total years of teaching experience ranged from 2 to 12 years and the years of experience in teaching biology ranged from 1 to 9 years as of September 1965.

All teachers had an undergraduate or graduate major in biological science with 35to 83 credit hours of biology, 20 to 84 credit hours in sciences other than biology, 4 to 13 credit hours in mathematics and 9 to 47 credit hours in education courses. Six teachers had masters' degrees and two teachers had baccalaureate degrees. Most of the teachers had taken additional work beyond their highest degrees and had attended one or more in-service institutes.

Five teachers, numbers 1 to 5, used the Biological Sciences Curriculum Study (BSCS) Yellow Version materials. One teacher, number 6, used the BSCS Green Version materials and two teachers used non-BSCS or "conventional" biology course materials.

Teachers 1, 2 and 3 taught in school number 1 which had an enrollment of 1,800 pupils in grades 9 to 12, teachers 4, 5 and 6 taught in school number 2 which had an enrollment of 3,000 pupils in grades 9 to 12, and teachers 7 and 8 taught in school number 3 which had an enrollment of 985 pupils in grades 10 to 12. The annual expenditure per pupil amounted to $650, $675 and $775 in schools 1, 2 and 3 respectively.

TABLE 1 SELECTED CHARACTERISTICS OF TEACHERS AND SCHOOLS CO-OPERATING IN THIS STUDY

Characteristics	Teacher Number								
	1	2	3	4	5	6	7	8	Ave.
Age as of 9/65	26	31	-	32	32	40	25	26	30
Sex	M	M	M	M	M	M	F	M	-
Total years teaching - 9/65	2	8	3	4	6	12	3	4	5
Years teaching Sci. sub. - 9/65	-	2	3	4	-	12	3	4	5
Years teaching Biol. - 9/65	2	8	2	1	6	9	3	1	4
Highest degree held	MS	MS	BA	MS-M.Ed.	M.Ed.	MS(Ed.)	BS	BS	-
Additional credit hours	19	3	22	-	3	0	15	24	14
Undergraduate Major	Bio.	Bio.	Bio.	Bio.	Forestry	Zool.	Bio.	Sci.	-
Graduate Major	Bio.	Bio.	-	Bio.	Ed.	Sci.Ed.	Ed.	Bio.	-
Graduate Minor	Sci.Ed.	-	-	Ed.	-	-	Geog.	-	-
Credit hours in Biology	36	62	36	65	83	45	45	35	51
Credit hours in other sciences	20	30	41	30	23	27	29	84	36
Credit hours in math	6	4	13	9	6	12	6	6	8
Credit hours in Education	47	29	9	24	18	21	9	35	24
No. of In-Service Institutes	3	2	2	4	0	0	1	1	2
No. of pupils in High School	1800	1800	1800	3000	3000	3000	985	985	2046
Annual per pupil Expenditure	650	650	650	675	675	675	775	775	691

As shown in Table 2, the number of pupils per class ranged from 15 to 37, however there were approximately equal numbers of students in the two classes taught by each teacher. The numbers of boys and girls within each class were not equal but the total number of boys and girls in the sample of 16 classes were almost equal -- 194 boys and 196 girls.

The scheduled duration of each lecture-recitation-discussion period was about 45 minutes in all cases except class number 82 which had 56 minute periods. However the observer noted that all teachers did not start or end the class according to schedule and thus there were somewhat different amounts of time devoted to lecture-discussion ranging from 32 to 55 minutes per period.

Biology is usually taught in the tenth grade in Central New York State schools and most of the pupils observed in the 16 classes were sophomores. However the higher ability-level classes of teachers one and two and class number 31 of teacher three had a number of ninth graders. Also, most classes had a few juniors or seniors who had been unable to take biology in their sophomore year for a variety of reasons.

Data on selected characteristics of pupils, such as, IQ, SCAT, the cummulative average of four subjects (English, Social Studies, Math and Science) for 1964-'65 i.e., the year preceeding the observation, the mid-term cummulative average of four subjects for the "current" year (1965-'66), and the biology grade at mid-term of the current year etc. were obtained from pupil records made available by the three schools. Class means and standard deviations are presented in Table 2. However, the reader should note the following. The IQs recorded for pupils in schools 1 and 2 (classes of teachers 1 to 6) were predominantly the total scores on the California Test of Mental Maturity (CTMM) given when the students were in the sixth grade. School 3 did not use the CTMM but instead had scores on the Lorge Thorndike Intelligence Test (LT) given in the sixth grade. Moreover, within the various classes a few students were "transfers" from other schools and did not have IQ scores in their records or had scores based on some other test. The reader's attention is also drawn to the fact that the cummulative or final average of four subjects for 1964-'65 academic year of any two students in a given class may not be strictly comparable since they may have had different teachers or been in different sections. Thus the various indices of ability are somewhat crude and need to be interpreted with caution. However, inspection of the means and standard deviations reported in Table 2 indicates that the two average ability classes each of teachers 3 to 7 appear to have similar ability level distributions and that the ability levels of two classes each of teachers 1, 2 and 8 appear to be quite different. For instance, the mean IQs of the two high ability classes (numbers 12 and 22) were about 130, while the mean IQs of the

TABLE 2 SELECTED CHARACTERISTICS AND ACHIEVEMENT SCORES OF PUPILS IN 16 BIOLOGY CLASSES

Characteristics		Teacher and Class Number																
		11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Ave.
No. Boys		11	15	20	21	10	13	14	10	10	6	12	12	9	13	8	9	12
No. Girls		21	22	12	12	11	11	7	11	5	11	11	14	14	10	9	15	12
No. Pupils		32	37	32	33	21	24	21	21	15	17	23	26	23	23	18	24	24
Duration of Period		47	47	47	43	43	47	43	41	48	43	45	48	46	42	46	56	46
Ave. Min. Class/Day		40	39	40	37	40	40	32	34	44	35	36	45	40	42	43	55	40
Ability Level		Av.	Hi.	Av.	Hi.	Av.	Av.	Av.	Av.	Av.	Av.	Av.	Av.	Av.	Av.	Lo.	Av.	-
IQ.	)M	109	130	117	131	125	119	115	111	109	115	117	115	117	110	91	115	115
	)SD	10.3	11.9	9.8	10.6	12.3	7.9	7.3	9.3	11.7	9.6	7.4	7.8	11.7	9.5	15.6	10.5	-
SCAT	)M	286	302	291	303	291	289	-	-	-	-	-	-	-	-	-	-	294
	)SD	8.2	7.5	6.9	8.4	8.4	6.1	-	-	-	-	-	-	-	-	-	-	-
Final Ave.	)M	78	87	81	87	80	78	82	80	80	82	83	84	83	79	71	84	82
4 subjects 6/65	)SD	5.3	3.6	6.4	3.6	6.0	5.9	5.6	6.1	8.8	4.6	4.5	5.4	7.1	6.9	4.1	6.4	-
Mid-Term Grade	)M	74	89	76	86	76	72	77	75	79	80	82	80	80	75	71	80	78
4 subjects 1/66	)SD	7.0	5.3	7.1	4.5	8.3	7.9	7.8	7.7	10.5	5.1	4.4	7.9	7.8	8.0	5.0	8.4	-
Mid-Term Grade	)M	67	82	70	80	70	69	79	76	84	81	82	80	79	74	72	81	76
Bio. 1/66	)SD	9.5	7.8	11.0	6.0	10.8	11.0	6.8	8.8	9.9	6.2	4.4	8.6	11.7	10.9	6.8	9.6	-
MSQ	)M	166	172	167	180	159	153	175	163	172	165	143	164	180	180	189	180	169
	)SD	23.1	19.9	23.8	19.5	19.8	16.2	22.5	22.0	21.2	21.1	24.7	19.9	10.0	23.9	15.7	21.1	-
Regents Bio.	)M	72	85	74	84	73	69	66	60	70	68	83*	81*	74	73	64*	74	73
Grade 6/66	)SD	10.3	7.2	9.5	8.6	83	8.9	10.7	12.1	13.8	9.5	6.0*	10.9*	11.4	8.9	10.8*	10.6	-
School Bio.	)M	70	83	72	82	71	70	77	73	83	82	80	78	78	73	72	79	76
Grade 6/66	)SD	8.5	5.9	8.6	5.9	9.0	7.9	8.3	11.2	9.5	4.5	5.3	11.8	9.5	8.4	5.6	8.7	-

* Regents exam not given, scores are grades on teacher-made final exam.

average ability classes were about 115 (a rather high figure for an "average") and the mean IQ of the low ability class (number 81) was 91.

An "attitude inventory", the Michigan Student Questionnaire (MSQ) developed by Ned Flanders and modified by Snider (39) for high school students was administered by the teachers about two weeks after the observation period as per directions given by the investigator. Parenthetically, a test of personality viz., the California Psychological Inventory could not be administered as originally intended (due to a revision of administrative policy) but administration of the M.S.Q. was permitted.

The grades on the N.Y. Regents Exams in Biology and the final grade in biology for the year given by each teacher are also included in Table 2. According to the rationale of this study these scores should be related to (or partially due to ?) pupils' classroom behavior and hence do not belong in the category of pupil characteristics but rather in the category of achievement scores.

Some remarks about the selection of the sample are appropriate at this point. The research strategy underlying the writer's long range program of research can be described as proceeding from the descriptive natural history type of investigation to correlational and ultimately experimental studies. The present study is predominantly in the natural history phase and is aimed at developing observational techniques and describing classroom behavior in a few carefully selected high school biology lecture-recitation-discussion classes. A random sample large enough to be representative of the wide variety of high school biology classes in New York State or even Central New York State would have been premature and also beyond the available resources of time, money and manpower. Other considerations also mitigated against random selection of even a small sample. Since a record of natural and spontaneous classroom behavior was desired teachers were selected only if they were willing to have their classes observed and tape-recorded while doing what they ordinarily would do if an observer were not present. However the writer did request that if possible the teachers refrain from using more than a third of a class period for testing or showing a film during the scheduled observation periods.

Admittedly, numerous factors can reasonably be hypothesized as affecting classroom behavior and it would be virtually impossible to have an adequate representation of all these factors. Since the ability level of a class is generally considered to be one of the factors, or rather a complex of associated factors, having the greatest effect on classroom behavior the investigator used ability level as the major criterion and deliberately chose classes in which the pupils were homogenously grouped on the basis of high, average or low ability and classes where pupils were heterogenously grouped regardless of ability. Parenthetically, in the original conception of the study equal numbers (three each) of high, average and low ability classes were to be selected but owing to a number of budgetary and administrative factors the sample was restricted to two high ability classes, one low ability class and thirteen average ability classes.

While it is not the aim of this study to determine what factors do in fact affect pupil participation, and to what extent, the writer felt that in addition to accomplishing the major objectives of the study (viz. instrumentation and description) a preliminary exploration of the relationship between pupil characteristics such as IQ, sex, etc. and pupil classroom behavior would be valuable and provide guidance for future correlational research.

General Design and Observation Procedures

The sixteen high school biology classes (two classes each of eight teachers) were observed for four consecutive days after an initial acclimatization visit. Two related observational techniques and systems were used -- one to obtain data on the verbal behavior of each pupil and two to obtain data on the verbal interaction between teacher and pupils.

Data on the verbal behavior of each pupil were obtained by using seating charts and coding the (live) verbal behavior as it occurred. Each pupil-utterance was coded into one of the thirty-six mutually exclusive categories of the Pupil Verbal-Behavior Category System as described previously under "Technique for Observation". (See also Appendix B). The observational record at the end of each class period consisted of the number and kinds of verbal behavior observed for each pupil and those utterances that were made by a group of pupils as well as utterances by unidentifiable speakers. The data from the seating charts were transferred to IBM coding sheets, punched on IBM cards and processed to yield classroom behavior scores on the various categories for each of the 390 pupils. These scores were grouped and regrouped in various ways and treated to yield the findings described in the chapter on Results.

The verbal interaction between teacher and pupils was also recorded for the entire duration of each observational visit. A briefcase-sized battery-operated portable (Norelco 101) tape-recorder was used. While the teacher and pupils were informed in advance that the classes would be recorded, the recording was done as inconspicuously as possible so as not to constantly remind the classes that they were being recorded. The discourse on the tapes (supplemented by the observer's notes) was categorized at a later date by a graduate assistant trained by the writer. The training was continued until values of 0.7 or higher for Scott's coefficient of inter-observer agreement (33) between the writer and the graduate assistant were obtained. As an additional check, after the verbal discourse on all 64 tapes had been categorized, four tapes were selected at random and categorized again by the assistant. Scotts coefficients were computed as a measure of stability of coding and again exceeded 0.7.

The discourse recorded on the tapes was categorized according to the teacher-pupil interaction analysis system developed by the writer in a previous study (29). (See Appendix A).

Briefly, the following coding procedure was used. Keeping as steady a tempo as possible, the observer wrote down one category number every five seconds to represent the behavior in that five second interval. If shifts or changes in the category of behavior occurred more rapidly then these shifts were also coded so as not to miss such behavior. At the end of each class period of about 40 minutes the observational record would consist of about 500 category numbers written in the sequence in which the classroom verbal behavior had occurred. For example, ...6F, 6F, 6F, 8D, 8D, 15D, 3... represents a sequence wherein the teacher states facts (about 15 seconds), then asks for a definition (about 10 seconds), a pupil gives a definition (about 5 seconds), the teacher qualifies or corrects the definition (about 5 seconds).

The interaction data were punched on IBM data cards in such a manner as to preserve the original sequence of category numbers. The data were electronically processed to yield the number and percentages of tallies in each of the forty-five categories for each of the classes and for all classes combined. In addition to these "scores" the data were plotted to yield interaction matrices for each class and for all classes combined.

The matrices were plotted according to the method proposed by Amidon and Flanders (2) and described in detail by the writer in a previous study (29). Briefly, plotting an interaction matrix entails treating the original sequence of numbers as overlapping pairs and entering a tally for the first member of each pair in the appropriate horizontal row and the second member in the appropriate vertical column that intersects the horizontal row to form a cell. For example, a sequence 1, 3, 3, 2, consists of three overlapping pairs, namely 1-3, 3-3 and 3-2. The first pair would yield a tally in the cell formed by row 1 and column 3, the second pair would yield a tally in the cell formed by row 3 and column 3 and so on. The reader, unfamiliar with interaction matrices may examine Table 11 in the "Results" section for an example.

Inspection of the data showed that there were negligibly few, if any, entries in category 17, i.e., interaction unclassifiable in the system. This confirmed that the category system was exhaustive and category 17 was eliminated from further consideration. Matrices of two sizes, 16 X 16 and 31 X 31, were then plotted -- these two sizes permit analysis of teacher-pupil interaction at two levels of detail. In order to plot the 16 X 16 matrices, all sub-categories were pooled or collapsed into the appropriate parent or major category. For instance, all sub-categories of category 6, namely 6U, 6D, 6F, 6X, 6E, 6N, 6L, were entered or tallied as "6". Thus, the rows and columns of the 16 X 16 matrices correspond to the 16 major categories of the teacher-pupil interaction system.

The 31 X 31 matrix (see Table 13 for example) was plotted by pooling those sub-categories which upon inspection of the data were found to have virtually no entries. This was done in order to make the matrices more manageable since a 45 X 45 matrix containing all sub-categories is rather unwieldy. These pooled sub-categories are designated as 6+, 7+, 8+, 14+ and 15+ respectively. Hence, in the 31 X 31 matrix, 6+ is a summation of 6U, 6N, 6L; 7+ is a summation of 7, 7C and 7S; 8+ is a summation of 8U, 8N, 8P; 14+ is a summation of 14U, 14E, 14N; and 15+ is a summation of 15U, 15E, 15N, 15L, 15P and 15R.

The figures in the cells in all matrices were rounded to 0.1% and have been reported without the decimal points, i.e., as tallies per thousand or 10 X % of total tallies. Thus an "empty cell" in a matrix indicates either a complete absence of the particular sequence of behavior or an occurrence of less than 0.05%. This slight loss of information and accuracy is counter balanced by the gain in readability of the matrices.

CHAPTER III

RESULTS AND DISCUSSION

In the interest of clarity and economy of presentation the results will be discussed primarily in terms of the "average" teacher, pupil and class with the realization that discussions in terms of the average or more accurately the composite teacher, or pupil or class seldom, if ever, do full justice to the diversity found in reality. However, an appreciation of the variety of classroom behavior can be gained by examining the range of "scores" presented in various tables. The reader is again reminded that the data obtained from the small sample selected in this study do not permit wide generalizations applicable to all biology teachers, pupils and classes.

A major outcome or result of this study was the development of a reliable observational technique and a set of thirty-six categories for the study of pupil-participation or verbal behavior of each pupil in biology lecture-recitation-discussion classes. Since these have been briefly described in the chapter on "Method" and in greater detail in Appendix B, the techniques and categories will not be repeated here.

The findings reported below are organized under three major headings, viz., the nature and distribution of pupil participation, the nature and patterns of teacher-pupil interaction and relationships between and among four classes of variables: pupil characteristics, pupil behaviors, teacher behaviors, and pupil achievement.

NATURE AND DISTRIBUTION OF PUPIL PARTICIPATION

Pupil (verbal) participation data were analyzed according to the number and relative frequencies of occurrence of various categories of pupil-talk; according to the number and percentages of pupils per class who participated in various categories of pupil talk; and by a combination of the above two, i.e., the number of utterances produced by the number of pupils.

Number and Relative Frequency of Utterances in Various Categories

Inspection of the observation records revealed that almost all of the 3,000 utterances of 390 pupils in four periods of observation were found in twenty of the thirty-six categories developed in this study. The twenty categories were those formed by the four modes (Q, S, V, R) and five kinds of utterances (D, F, X, E, R). There were negligibly few or no instances of four kinds of utterances, viz., Nature of Science (N), Limitation of Knowledge (L), Problem-Solving Procedures (P), and Unclassifiable (U). In the interest of economy of presentation it was decided to include or pool the few utterances in N, L, P, and U along with Routine (R) utterances and rename the pooled utterances as Routine and Other (OT). Furthermore, all utterances categorized as D or F and as X or E were combined to generate two new categories, namely, DF and XE on the assumption that DF and XE represent qualitatively lower and higher orders of quasi-logical operations in classroom discourse -- or at least in the observed discourse. The number and relative frequencies of utterances in various categories of pupil behavior in the sixteen biology classes are shown in Tables 3 and 4 respectively. These figures include utterances that were coded as group utterances and as unattributable to a specific speaker. (The reader may recall that the actual amount of time spent in lecture-recitation-discussion varied somewhat as shown in Table 2. However, a recomputation of total scores for each class to adjust for time produced negligible changes such as an increase in the total number of utterances from 2,980 to 3,007 and a change in the average from 186 to 188 utterances. The scores reported herein have not been adjusted for time).

Total Pupil-Talk

The total number of pupil-utterances per class in the four periods of observation varied greatly, ranging from 73 to 354, with an average of 186 utterances. Stated alternatively, in one class period of about 40 minutes there were 47 utterances by the aggregate of pupils. Moreover, from data collected in another phase of the study and reported later, it was found that in the average class, total pupil-talk accounted for about 17% of the total class time -- teacher-talk accounted for about 78% of the time and silent pauses accounted for about 4% of the time.

The above data indicate that biology classroom discussion, or rather discourse, is strikingly asymmetric and the teacher talks approximately four to five times as much as all the pupils combined.

Modes of Participation

The percentages of utterances in the four modes of participation in the average or composite class are shown in Table 4 as follows: Questioning (Sum Q) 16%, Making Self-Initiated Statements (Sum S) 5%, Volunteering Responses (Sum V) 50%, and Replying (Sum R) 29%.

TABLE 3 NUMBER OF UTTERANCES IN VARIOUS CATEGORIES OF PUPIL BEHAVIOR IN 16 BIOLOGY CLASSES

Category	Teacher and Class Number																		
	11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Sum	Ave	Range
QD	3	5	0	3	2	8	1	5	3	2	3	3	0	1	2	2	43	3	0-8
QF	8	6	5	10	13	12	5	15	4	2	15	11	2	4	5	14	131	8	2-15
QX	12	15	9	13	15	28	4	17	2	4	23	12	8	11	13	21	207	13	2-28
QE	0	1	1	2	0	0	0	0	0	0	0	1	0	0	0	0	5	0.3	0-2
QOT	6	12	8	8	3	5	10	10	2	5	2	2	3	9	5	2	92	6	2-12
QDF	11	11	5	13	15	20	6	20	7	4	18	14	2	5	7	16	174	11	2-20
QXE	12	16	10	15	15	28	4	17	2	4	23	13	8	11	13	21	212	13	2-28
Sum Q	29	39	23	36	33	53	20	47	11	13	43	29	13	25	25	39	478	30	11-53
SD	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0.1	0-1
SF	1	2	11	13	8	9	0	3	0	2	5	1	0	0	0	2	57	4	0-13
SX	1	13	3	10	20	12	1	2	2	0	2	1	0	0	0	5	72	5	0-20
SE	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4	0.3	0-4
SOT	0	0	0	0	0	2	2	0	0	0	1	2	0	1	0	0	8	1	0-2
SDF	1	2	12	13	8	9	0	3	0	2	5	2	0	0	0	2	59	4	0-13
SXE	1	13	3	10	24	12	1	2	2	0	2	1	0	0	0	5	76	5	0-24
Sum S	2	15	15	23	32	23	3	5	2	2	8	5	0	1	0	7	143	9	0-32
VD	9	8	26	5	18	20	9	5	15	1	5	12	12	9	48	16	218	14	1-48
VF	16	21	57	47	13	44	17	24	5	15	10	13	25	36	37	17	0	25	5-57
VX	41	43	74	70	71	91	23	28	15	2	18	21	41	41	15	49	0	40	2-91
VE	3	0	11	19	7	4	0	0	0	0	0	0	17	21	2	0	84	5	0-21
VOT	1	1	28	20	5	7	14	12	5	5	11	14	4	2	11	4	144	9	1-28
VDF	25	29	83	52	31	64	26	29	20	16	15	25	37	45	85	33	615	38	15-85
VXE	44	43	85	89	78	95	23	28	15	2	18	21	58	62	17	49	727	45	2-95
Sum V	70	73	196	161	114	166	63	69	40	23	44	60	99	109	113	86	1486	93	23-196
RD	10	5	7	1	5	3	0	1	8	6	0	1	32	28	22	4	0	8	0-32
RF	33	34	14	23	13	10	0	0	6	12	0	0	24	22	24	5	0	14	0-34
RX	20	27	36	18	13	12	1	1	27	6	3	5	61	52	2	14	298	19	1-61
RE	2	1	2	2	4	0	0	0	0	0	0	0	0	2	0	0	13	1	0-4
ROT	8	14	61	17	5	9	9	2	2	11	3	11	24	15	13	5	209	13	2-61
RDF	43	39	21	24	18	13	0	1	14	18	0	1	56	50	46	9	353	22	0-56
RXE	22	28	38	20	17	12	1	1	27	6	3	5	61	54	2	14	311	19	1-61
Sum R	73	81	120	61	40	34	10	4	43	35	6	17	141	119	61	28	873	55	4-141
Sum D	22	18	34	9	25	31	10	11	26	9	8	17	44	38	72	22	396	25	9-72
Sum F	58	63	87	93	47	75	22	43	15	31	30	25	51	62	66	38	806	50	15-93
Sum X	74	98	122	111	103	131	28	48	46	12	46	40	110	104	30	87	1190	74	12-131
Sum E	5	2	14	23	31	16	1	0	0	0	0	0	17	23	2	2	136	9	0-31
Sum OT	15	27	97	45	13	23	35	24	9	21	17	29	31	27	29	11	453	28	9-97
Sum DF	80	81	121	102	72	106	32	53	41	40	38	42	95	100	138	60	1201	75	32-138
Sum XE	79	100	136	134	134	147	29	48	46	12	46	40	127	127	32	89	1326	83	12-147
Total	174	208	354	281	219	276	96	125	96	73	101	111	253	254	199	160	2980	186	73-354

TABLE 4 RELATIVE FREQUENCIES OF VARIOUS CATEGORIES OF PUPIL BEHAVIOR IN 16 BIOLOGY CLASSES a/

Category	Teacher and Class Number																	
	11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Ave	Range
QD	2	2	0	1	1	3	1	4	3	3	3	3	0	0	1	1	2	0-4
QF	5	3	1	4	6	4	5	12	4	3	15	10	1	2	3	9	4	1-15
QX	7	7	3	5	7	10	4	14	2	5	23	11	3	4	7	13	7	2-23
QE	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0.2	0-1
QOT	3	6	2	3	1	2	10	8	2	7	2	2	1	4	3	1	3	1-10
QDF	6	5	1	5	7	7	6	16	7	5	18	13	1	2	4	10	6	1-18
QXE	7	8	3	5	7	10	4	14	2	5	23	12	3	4	7	13	7	2-23
Sum Q	17	19	6	13	15	19	21	38	11	18	43	26	5	10	13	24	16	5-43
SD	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0.1	0-1
SF	1	1	3	5	4	3	0	2	0	3	5	1	0	0	0	1	2	0-5
SX	1	6	1	4	9	4	1	2	2	0	2	1	0	0	0	3	2	0-9
SE	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0.1	0-2
SOT	0	0	0	0	0	1	2	0	0	0	1	2	0	0	0	0	0.3	0-2
SDF	1	1	3	5	4	3	0	2	0	3	5	2	0	0	0	1	2	0-5
SXE	1	6	1	4	11	4	1	2	2	0	2	1	0	0	0	3	3	0-11
Sum S	1	7	4	8	15	8	3	4	2	3	8	5	0	0	0	4	5	0-15
VD	5	4	7	2	8	7	9	4	16	1	5	11	5	4	24	10	7	1-24
VF	9	10	16	17	6	16	18	19	5	21	10	12	10	14	19	11	13	5-21
VX	24	21	21	25	32	33	24	22	16	3	18	19	16	16	8	31	22	3-33
VE	2	0	3	7	3	1	0	0	0	0	0	0	7	8	1	0	3	0-8
VOT	1	0	8	7	2	3	15	10	5	7	11	13	2	1	6	3	5	0-15
VDF	14	14	23	19	14	23	27	23	21	22	15	23	15	18	43	21	21	14-43
VXE	25	21	24	32	36	34	24	22	16	3	18	19	23	24	9	31	24	13-36
Sum V	40	35	55	57	52	60	66	55	42	32	44	54	39	43	57	54	50	32-66
RD	6	2	2	0	2	1	0	1	8	8	0	1	13	11	11	3	5	0-13
RF	19	16	4	8	6	4	0	0	6	16	0	0	9	9	12	3	7	0-19
RX	11	13	10	6	6	4	1	1	28	8	3	5	24	20	1	9	10	1-28
RE	1	0	11	1	2	0	0	0	0	0	0	0	0	1	0	0	0.4	0-11
ROT	5	7	7	6	2	3	9	2	2	15	3	10	9	6	7	3	7	0-17
RDF	25	19	6	9	8	5	0	1	15	25	0	1	22	20	23	6	12	0-25
RXE	13	13	11	7	8	4	1	1	28	8	3	5	24	21	1	9	10	1-28
Sum R	42	39	34	22	18	12	10	3	45	48	6	15	56	47	31	18	29	3-56
Sum D	13	8	9	3	11	11	10	9	27	12	8	16	18	15	36	14	13	3-36
Sum F	34	30	24	34	22	27	23	33	15	43	30	23	20	25	34	24	27	15-34
Sum X	43	47	35	40	54	51	30	39	48	16	46	36	43	40	16	56	40	16-56
Sum E	3	0	14	9	7	1	0	0	0	0	0	1	7	9	1	0	5	0-14
Sum ROT	9	13	17	16	5	9	36	20	9	29	17	27	12	11	16	7	15	3-36
Sum DF	46	39	33	38	33	38	33	43	43	55	38	39	38	40	70	38	40	31-70
Sum XE	46	48	39	48	62	52	30	39	48	16	46	37	50	49	17	56	45	16-62
Total	174	208	354	281	219	276	96	125	96	73	101	111	253	254	199	160	100	73-354

a/ Figures = % of Total Pupil Talk in each class.

The kinds of utterances within each of the modes arranged in decreasing order of occurrence in the average class were as follows:
(1) QX 7%, QF 4%, QOT 3%, QD 2%, and QE almost 0%.
(2) SX 2%, SF 2%, SD, SE, and SOT almost 0%.
(3) VX 22%, VF 13%, VD 7%, VOT 5%, and VE 3%.
(4) RX 10%, RF 7%, ROT 7%, RD 5%, and RE 1%.
Thus with few exceptions essentially the same order of occurrence, viz., X, F, OT, D and E was found within each of the modes.

Kinds of Utterances

In the average class the relative frequencies of the five kinds of utterances, summed across the four modes and arranged in decreasing order of occurrence, were: Explaining (Sum X) 40%, Fact-Stating (Sum F) 27%, Routine and Other (Sum OT) 15%, Defining (Sum D) 13%, and Evaluating (Sum E) 5%.

The percentage of total utterances constituting the higher (Sum XE) and lower levels (Sum DF) of quasi-logical operations in the average class were 45%, and 40% respectively -- the remaining 15% consisting of Routine and Other Utterances (Sum OT). Thus, there were approximately equal numbers or proportions of lower-level and higher-level utterances.

Number and Percentage of Pupils Participating in Various Categories

The number and percentages of pupils in each class observed behaving in the various categories during four lecture-discussion periods are shown in Tables 5 and 6 respectively.

Participants in Each Class

About 85% of the pupils in the average class were observed participating at least once during the four periods of observation (see row PT at bottom of Table 6). The proportion of "participants" ranged from 62 to 100% in the sixteen classes. In three classes all or 100% of the pupils participated whereas in the other thirteen classes about 4 to 38% of the pupils did not participate in the class discussion. It is of course possible, though not very likely, that the "non-participants" may have participated in group responses or in a manner unidentifiable by the observer.

A comparison of the total number of participants and the total number of pupils per class (see rows PT and N at bottom of Tables 5 and 6) showed that there was no direct relationship between the two. When the sixteen classes were grouped according to size -- small 15 to 18 pupils, average 21 to 26 pupils and large 32 to 37 pupils -- it was found that the percentage of participants ranged from 71 to 100% in the small classes, 62 to 100% in the average-sized classes and 81 to 100% in the large classes.

TABLE 5 NUMBER OF PUPILS IN EACH BIOLOGY CLASS OBSERVED BEHAVING IN VARIOUS CATEGORIES OF PUPIL BEHAVIOR

Category	Teacher and Class Number																		
	11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Sum	Ave	Range
QD	2	4	0	2	2	4	1	2	2	2	2	2	0	1	2	1	29	2	0-4
QF	5	5	4	5	5	5	3	5	3	1	7	8	2	3	3	9	73	5	1-9
QX	4	8	6	7	7	12	3	5	2	2	9	6	4	10	8	10	0	6	2-10
QE	0	1	1	2	0	0	0	0	0	0	0	1	0	0	0	0	5	0.3	0-5
QDT	5	8	5	6	3	3	4	4	2	3	1	2	3	9	4	2	64	4	1-9
QDF	6	8	4	7	7	8	4	6	3	3	8	9	2	4	4	9	92	6	2-9
QXE	4	9	7	8	7	12	3	5	2	2	9	6	4	10	8	10	106	7	2-10
All Q	9	14	10	12	9	12	6	9	7	5	11	10	8	15	10	12	0	10	6-14
SD	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0.1	0-1
SF	1	2	4	8	3	8	0	2	0	2	4	1	0	0	0	1	36	2	0-8
SX	1	6	3	4	4	5	1	2	1	0	2	1	0	0	0	3	33	2	0-6
SE	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0.2	0-3
SDT	0	0	0	0	0	1	1	0	0	0	1	2	0	1	0	0	5	0.4	0-6
SDF	1	2	4	8	3	8	0	2	0	2	4	2	0	0	0	1	37	2	0-8
SXE	1	6	3	4	6	5	1	2	1	0	2	1	0	0	0	3	0	2	0-6
All S	2	7	6	10	6	9	2	4	1	2	5	5	0	1	0	4	64	4	0-10
VD	5	6	11	3	6	9	6	3	10	1	4	4	7	6	10	7	98	6	1-11
VF	8	9	13	14	6	15	9	11	3	8	4	6	9	8	5	7	135	8	3-15
VX	12	12	17	17	10	16	10	6	4	2	8	9	11	16	6	12	168	11	2-17
VE	3	0	5	5	5	2	0	0	0	0	0	0	2	3	0	0	25	2	0-5
VDT	0	1	9	2	3	3	6	3	3	2	4	3	1	0	3	2	45	3	0-9
VDF	9	10	16	15	9	16	12	11	10	8	8	9	12	10	11	9	175	11	8-16
VXE	12	12	19	17	12	16	10	6	4	2	8	9	12	16	6	12	0	11	2-19
All V	14	17	23	20	15	19	15	11	11	8	12	14	15	17	11	13	0	15	11-23
RD	7	5	6	1	3	3	0	1	7	4	0	1	15	13	13	4	83	5	0-15
RF	22	27	9	10	9	7	0	0	4	6	0	0	11	13	17	5	140	9	0-27
RX	11	13	19	14	9	7	1	1	11	5	3	4	16	18	1	8	141	9	1-19
RE	1	1	2	2	4	0	0	0	0	0	0	0	0	2	0	0	12	1	0-4
RDT	7	9	26	11	4	6	7	2	2	6	3	8	14	8	8	4	125	8	2-26
RDF	22	28	13	11	9	7	0	1	9	8	0	1	20	18	18	9	174	11	0-28
RXE	11	13	20	15	10	7	1	1	11	5	3	4	16	18	1	8	144	9	1-20
All R	25	29	32	24	15	12	8	2	13	11	6	10	22	22	8	15	254	16	2-32
All D	10	12	16	5	9	9	5	4	11	6	7	8	17	13	14	8	0	10	4-17
All F	24	28	18	21	10	16	10	11	9	12	9	10	16	17	17	14	242	15	9-28
All X	16	22	27	24	13	17	11	7	13	8	12	13	20	22	10	16	251	16	7-27
All E	3	2	6	8	9	2	0	0	0	0	0	1	2	5	0	0	38	2	0-9
All DT	10	13	27	18	7	9	12	7	6	7	7	11	15	16	11	7	183	11	6-27
All DF	24	29	23	21	13	17	12	12	11	12	14	13	21	20	18	16	276	17	11-29
All XE	16	23	28	24	14	17	11	7	13	8	12	13	22	22	10	16	256	16	7-28
All PT	28	30	32	30	17	21	17	13	14	12	15	19	22	23	18	22	333	21	12-32
N	32	37	32	33	21	24	21	21	15	17	23	26	23	23	18	24	390	24	15-37

TABLE 6 PERCENTAGES OF PUPILS IN EACH BIOLOGY CLASS OBSERVED BEHAVING IN VARIOUS CATEGORIES OF PUPIL BEHAVIOR a/

Category	Teacher and Class Number																	
	11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Ave	Range
QD	6	11	0	6	10	17	5	10	13	12	9	8	0	4	11	4	7	0-17
QF	16	14	13	15	24	21	14	24	20	6	30	31	9	13	17	38	19	6-38
QX	13	22	19	21	33	50	14	24	13	12	39	23	17	43	44	42	26	12-50
QE	0	3	3	6	0	0	0	0	0	0	0	4	0	0	0	0	1	0-6
QOT	16	22	16	18	14	13	18	19	13	18	4	8	13	39	22	8	16	4-39
QDF	19	22	13	21	33	33	18	29	20	18	35	35	9	17	22	38	24	9-38
QXE	13	24	22	24	33	50	14	24	13	12	39	23	17	43	44	42	27	12-50
All Q	28	38	31	36	43	50	27	43	47	29	48	38	35	65	56	50	41	28-65
SD	0	0	3	0	0	0	0	0	0	0	0	4	0	0	0	0	0.5	0-4
SF	3	5	13	24	14	33	0	10	0	12	17	4	0	0	0	4	9	0-35
SX	3	16	9	12	19	21	5	10	7	0	9	4	0	0	0	13	8	0-21
SE	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	1	0-14
SOT	0	0	0	0	0	4	5	0	0	0	4	8	0	4	0	0	2	0-8
SDF	3	5	13	24	14	33	0	10	0	12	17	8	0	0	0	4	9	0-33
SXE	3	16	9	12	29	21	5	10	7	0	9	4	0	0	0	13	9	0-29
All S	6	19	19	30	29	38	9	19	7	12	22	19	0	4	0	17	16	0-38
VD	16	16	34	9	29	38	27	14	67	6	17	15	30	26	56	29	25	6-67
VF	25	24	41	42	29	63	41	52	20	47	17	23	39	35	28	29	35	17-63
VX	38	32	53	52	48	67	45	29	27	12	35	35	48	70	33	50	43	12-70
VE	9	0	16	15	24	8	0	0	0	0	0	0	9	13	0	0	6	0-24
VOT	0	3	28	6	14	13	27	14	20	12	17	12	4	0	17	8	12	0-28
VDF	28	27	50	45	43	67	55	52	67	47	35	35	52	43	61	38	45	27-67
VXE	38	32	59	52	57	67	45	29	27	12	35	35	52	70	33	50	45	12-70
All V	44	46	72	61	71	79	68	52	73	47	52	54	65	74	61	54	60	44-79
RD	22	14	19	3	14	13	0	5	47	24	0	4	65	57	72	17	21	0-72
RF	69	73	28	30	43	29	0	0	27	35	0	0	48	57	94	21	36	0-94
RX	34	35	59	42	43	29	5	5	73	29	13	15	70	78	6	33	36	5-78
RE	3	3	68	6	19	0	0	0	0	0	0	0	0	9	0	0	3	0-68
ROT	22	24	14	33	19	25	32	10	13	35	13	31	61	35	44	17	32	10-61
RDF	69	76	16	33	43	29	0	5	60	47	0	4	87	78	100	38	45	0-100
RXE	34	35	31	45	48	29	5	5	73	29	13	15	70	78	6	33	37	5-73
All R	78	78	100	73	71	50	36	10	87	65	26	38	96	96	100	63	65	10-100
All D	31	32	50	15	43	38	24	17	73	35	31	31	74	57	78	33	39	15-78
All F	75	76	56	64	78	67	48	58	60	71	39	39	70	74	95	58	62	39-95
All X	50	59	84	73	62	71	53	33	87	47	52	50	87	96	56	67	64	33-96
All E	9	5	19	24	43	8	0	0	0	0	0	4	9	22	0	0	10	0-43
All OT	31	35	85	55	33	38	57	33	40	41	30	42	65	70	61	29	47	29-85
All DF	75	78	72	64	62	71	57	57	73	71	61	50	91	87	100	67	71	50-100
All XE	50	62	88	73	67	71	53	33	87	47	52	50	96	96	56	67	66	33-96
All PT	88	81	100	91	81	88	77	62	93	71	65	73	96	100	100	92	85	62-100
N	32	37	32	33	21	24	21	21	15	17	23	26	23	23	18	24	24	15-37

a/ Figures = % of Number of Pupils (N) in each class. Summation figures, e.g., DF, Sum of All QS etc. are obtained by counting and not by addition because pupils often participate in more than one category and hence sums do not add up arithmetically.

Participants and Modes of Participation

The percentages of pupils in the average class that participated in one or more of the four modes, as shown in Table 6, were as follows: Questioning (All Q) 41%, Self-Initiated Statements (All S) 16%, Volunteering (All V) 60% and Replying (All R) 65%. The percentages add up to more than 100 due to the same pupil participating in more than one of the four modes. As a matter of interest, it was determined (by counting) that 62 out of the 390 pupils or 16% of the pupils participated or replied only when specifically called upon by the teacher.

Questioning, Making Self-Initiated Statements and Volunteering (Q, S, and V) all require varying amounts of initiative or voluntary participation on the part of pupils as compared to Replying upon call (R). Thus about 70% of the pupils were observed to take some initiative in class participation, 16% participated only if called upon and 15% did not participate verbally in class discussion.

The percentage of pupils in the average class who made different kinds of utterances within each of the modes, arranged in decreasing order, were as follows:
(1) QX 26%, QF 19%, QOT 16%, QD 7%, and QE 1%.
(2) SF 9%, SX 8%, SOT 2%, SE 1%, and SD less than 1%.
(3) VX 43%, VF 35%, VD 25%, VOT 12%, and VE 6%.
(4) RX 36%, RF 36%, ROT 32%, RD 21%, and RE 3%.
Thus with few exceptions essentially the same order, viz., S, F, OT, D, and E was found within each mode.

Participants and Kinds of Utterances

In the average class, the percentage of pupils participating in the five kinds of utterances, across all four modes and arranged in decreasing order, were: Explaining (All X) 64%, Fact-Stating (All F) 62%, Routine and Other (All OT) 47%, Defining (All D) 39%, and Evaluating (All E) 10%.

The percentage of pupils in the average class participating in the lower (All DF) and higher (All XE) levels of quasi-logical operations were 71% and 66% respectively.

The reader is again reminded that the percentages add up to more than 100 due to the same pupil making more than one kind of utterance. Inspection of the data showed considerable overlapping with relatively few pupils participating only at a "low level" or only at a "high level".

Distribution of Class Participation Among Pupils

In the preceding two sections the author essentially dealt with two major questions. (1) How much of various kinds of verbal behavior occurs in biology classes. (2) How many pupils participate in various kinds of verbal behavior. The answers to the above two questions can be combined in order to answer a third question, viz., How many pupils account for the total amounts of the different kinds or categories of verbal behavior?

Number of Participants and Utterances

Table 7 shows a comparison of the number of utterances in various categories and the number of pupils making those utterances in the average class of 24 pupils. It should be noted that the total of 186 utterances were made by 21 out of the 24 pupils. Also, the figures constituting the total number of students in row and column marked "Total" are obtained by counting and not by addition and do not add up arithmetically due to pupils participating in more than one category.

In the average class 30 Questions were asked by 10 pupils, 9 Self-initiated statements were made by 4 pupils, 93 Voluntary responses were made by 15 pupils and 55 Replies to teacher's specific request were given by 16 pupils. Stated alternatively in terms of kinds of utterances, 25 Definitions were given by 10 pupils, 50 Factual statements were made by 15 pupils, 75 Explanations were given by 16 pupils, 8 Evaluative statements were made by 2 pupils and 28 Routine and Other statements were made by 11 pupils. Also 75 "lower-level" utterances were made by 17 pupils and 83 "higher-level" utterances were made by 15 pupils. For detailed information regarding each category (such as QD, QF, etc.) the reader may study Table 7.

Degree or Level of Participation

Inspection of the observation record showed that participation in class discussion was not uniformly distributed, but rather a relatively small number of pupils accounted for most of the pupil-talk in each class. The number of pupils that contributed approximately one-fourth, one-half, three-fourths and all of the attributable participation in each of the four modes and selected quasi-logical operations are shown in Table 8. The 25%, 50%, 75%, and 100% levels of participation were selected somewhat arbitrarily.

In the average class two pupils accounted for about 25% of the pupil-talk (PT), four pupils accounted for about 50% of the pupil-talk, and nine pupils accounted for about 75% of the pupil-talk and 21 pupils accounted for all pupil-talk. With few exceptions these figures are fairly representative of all sixteen classes regardless of size, type of course, ability level, etc.

TABLE 7 NUMBER OF PUPILS ACCOUNTING FOR VARIOUS CATEGORIES OF PUPIL BEHAVIOR IN THE "AVERAGE CLASS" OF 24 PUPILS a/

Category	D	F	X	E	OT	DF	XE	Total
Q	3 b/	8	13	<1	6	11	13	30
	2 c/	5	6	0.	4	6	7	10
S	<1	4	5	<1	1	4	5	9
	0.	2	2	0.	0.	2	2	4
V	14	25	40	5	9	38	46	93
	6	8	11	2	3	11	12	15
R	8	14	18	1	13	22	20	55
	5	9	9	1	8	11	9	16
Total	25	50	75	8	28	75	83	186
	10	15	16	2	11	17	15	21

a/ Alphabetical combinations of row and column designations gives category symbol e.g., QD, QF, etc.

b/ Figures on top in each row are the average number of utterances in the particular category. Average was obtained by dividing all utterances in that category in 16 classes by 16.

c/ Figures at bottom of each row are the average number of pupils who participated in the particular category. Average was obtained by dividing the total number of pupils participating in that category in 16 classes by 16.

TABLE 8

NUMBER OF PUPILS ACCOUNTING FOR 25%, 50%, 75% AND 100% OF PARTICIPATION IN SELECTED CATEGORIES OF BEHAVIOR IN 16 BIOLOGY CLASSES

Category And % Level	Teacher and Class Number																	
	11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Sum.	Ave.
Q.25	1	2	1	2	1	2	1	1	1	1	1	1	1	3	1	2	22	1.4
Q.50	3	4	3	3	2	3	2	2	2	2	3	3	2	6	3	4	47	2.9
Q.75	4	6	6	7	3	6	3	4	5	3	6	5	4	9	4	7	82	5.1
Q100	9	14	10	12	9	12	6	9	7	5	12	10	8	15	10	12	160	10.0
S.25	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	14	.9
S.50	1	2	2	3	2	3	2	1	1	1	2	2	0	1	0	2	25	1.6
S.75	2	3	3	5	3	5	2	2	1	2	3	3	0	1	0	3	38	2.4
S100	2	9	6	10	7	8	2	3	1	2	5	5	0	1	0	4	65	4.1
V.25	1	1	2	2	1	2	1	2	2	1	1	2	1	2	1	2	24	1.5
V.50	3	2	3	5	2	4	3	3	4	3	3	4	4	4	2	4	53	3.3
V.75	5	6	7	9	3	8	8	8	7	5	4	7	7	8	5	8	105	6.6
V100	14	17	23	20	13	19	15	11	11	8	10	14	15	17	11	13	231	14.4
R.25	2	2	4	4	2	2	2	1	2	2	2	2	2	3	3	2	37	2.3
R.50	5	7	11	8	4	3	4	1	4	4	4	3	5	7	7	5	82	5.1
R.75	12	14	19	14	7	6	7	1	7	7	6	6	10	13	11	9	149	9.3
R100	26	29	32	24	13	12	8	2	13	22	8	10	22	22	18	15	276	17.3
OT.25	2	2	3	3	1	1	2	1	1	1	1	1	2	2	2	1	26	1.6
OT.50	4	4	8	7	2	3	4	2	2	2	2	3	5	4	4	3	59	3.7
OT.75	6	8	14	12	5	5	6	4	4	4	4	7	8	10	7	5	109	6.8
OT100	10	13	27	18	7	9	12	7	6	7	7	11	15	16	11	7	183	11.4
DF.25	2	2	2	2	1	2	2	1	1	1	1	2	2	2	1	2	26	1.6
DF.50	5	6	4	5	2	4	4	3	3	3	4	4	6	5	3	5	66	4.1
DF.75	10	14	9	11	3	7	7	5	6	6	6	6	11	10	8	9	128	8.0
DF.100	24	29	23	21	13	17	12	12	11	12	14	13	21	20	18	16	276	17.3
XE.25	1	1	1	2	1	2	2	1	2	1	1	1	2	3	2	2	25	1.6
XE.50	3	2	3	5	2	4	3	3	4	2	3	3	5	6	4	5	57	3.6
XE.75	5	8	10	9	4	7	6	4	7	5	6	6	9	11	8	8	113	7.1
XE100	16	23	28	24	14	17	11	7	13	8	12	13	22	22	10	16	256	16.0
PT.25	2	2	2	2	1	2	2	2	2	2	1	2	3	3	2	2	32	2.0
PT.50	4	4	5	6	2	4	4	3	4	4	4	5	6	7	4	5	71	4.4
PT.75	8	12	14	11	4	7	8	5	7	7	7	8	10	13	8	10	139	8.7
PT100	28	30	32	30	16	21	17	13	14	12	16	19	22	23	18	22	333	20.8
N	32	37	32	33	21	24	21	21	15	17	23	26	23	23	18	24	390	24

The number of pupils in the average class accounting for 25%, 50%, 75% and 100% of the participation in each of the four modes were: Questions, 1, 3, 5, and 10; Self-Initiated Statements, 1, 1.6, 2.4, and 4; Voluntary Responses, 2, 3, 7, and 15; and Replies to Teacher, 2, 5, 9, and 17.

The number of pupils in the average class accounting for 25%, 50%, 75%, and 100% of the participation in various kinds of utterances were: Routine and Other 2, 4, 7, and 11; "Lower-level" or Definitions and Facts 2, 4, 8, and 17; "Higher-level" of Explanations and Evaluations 2, 4, 7, and 16.

In short, the above figures clearly indicate that regardless of the modes of participation or the kind of utterance about four or five pupils account for half of all pupil utterances, about eight pupils account for about three-fourths of all pupil utterances. Thus, to use Bellack's phrase (8) the "classroom game" is played (at least in the 16 classes observed) primarily between a teacher who talks about 78% of the time and about five to eight pupils who account for 50% to 75% of pupil-talk.

Figure 1 shows a graphic comparison of the five highest participators in the sixteen classes and also enables comparison between two classes taught by each teacher. Five highest participators were chosen since, as mentioned above they generally accounted for over half of the attributed pupil-talk. There is an overall similarity in the proportion of pupil-talk produced by the five highest participators especially in the two classes taught by each teacher.

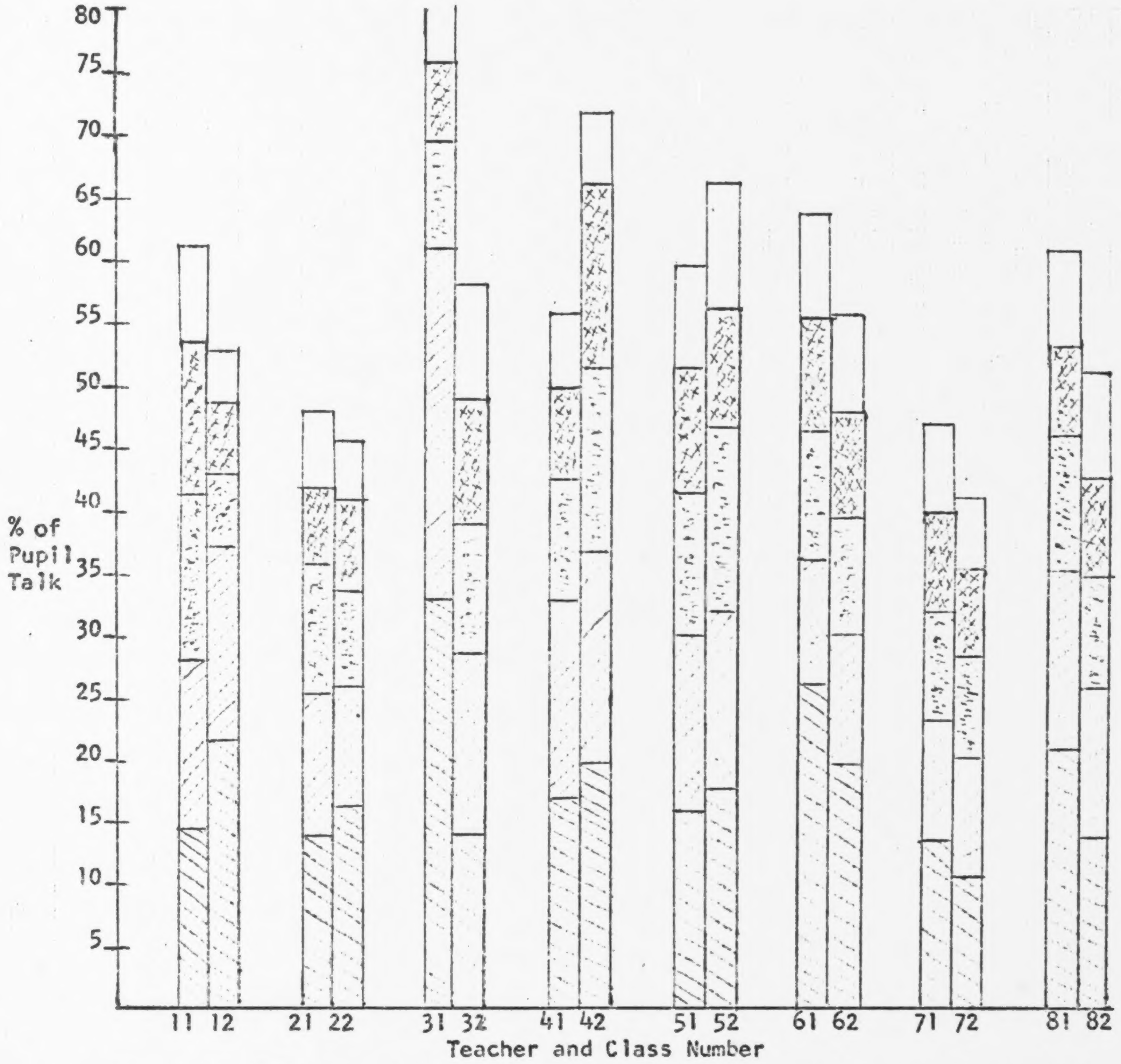

Figure 1. Relative class participation of the Five Highest Participants in 16 Biology Classes

THE NATURE OF TEACHER-PUPIL INTERACTION

The overwhelming wealth of data obtained from Interaction Analysis can be organized and presented in many ways. The data are usually presented as relative frequencies or percent scores in tabular and graphic form. In the ensuing sections the data from 4 lecture-recitation-discussion periods in each of the sixteen biology classes will be pooled. The number of observations recorded in each of the major categories and in the sub-categories will be expressed as the percentage of the total observations (about 2,000) in each class. This procedure reduces the raw data of over 33,000 observations or tallies to about 800 percentage scores as presented in Table 9. The writer views Table 9 as a "Master Table" in which a considerable amount of the quantitative information has been summarized. However, in order to highlight certain overall aspects and dimensions of classroom behavior various portions of the data from Table 9 are presented separately in Table 10.

The reader is reminded that in the teacher-pupil interaction system the observations are based on a time unit, i.e., each observation or entry represents about five seconds of time, rather than the number of utterances as was done in the pupil behavior category system. Hence, for the purpose of discussion, the interactive classroom behavior can be more conveniently referred to in terms of the amount of time spent in a given behavior. For example, in Table 9 Teacher 1 in his first period class (Class Number 11) praised pupils 0.1% of the total time. By reading across a given row in Table 9 the percentage of time devoted to any given category in the various classes can be compared. By reading down each column of figures the percentage of time devoted to the various categories in a particular class can be compared.

Relative Proportions of Teacher and Pupil-Talk

Teacher-Talk

The most conspicuous feature of the lecture-discussion classes observed in this study was the preponderance of teacher-talk. As shown in Table 10, teacher-talk ranged from 68 to 89% in the sixteen classes and the average teacher talked 78% of the time

These findings are almost identical to those found in a previous study (29) of primarily non-BSCS biology classes. Snider (39) using the Flanders system, also reported similar figures for a sample of seventeen high school Physics teachers and on the basis of further analysis of the kinds of teacher-talk concluded that "much of physics teaching is 'telling' (and) the implication is that there is little student inquiry in the learning process".

TABLE 9 RELATIVE FREQUENCIES OF INTERACTION-CATEGORIES IN TWO DIFFERENT CLASSES OF EIGHT BIOLOGY TEACHERS a/

Category		Teacher and Class Number																	
		11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Ave.	Range
T Praises	1	0.1	0.4	3.4	1.5	0.8	0.6	1.1	0.7	0.6	0.7	0.9	1.7	0.7	0.8	1.0	0.6	1.0	0.1- 3.4
T Accepts	2	6.5	6.1	6.6	5.3	4.4	5.9	3.7	4.2	3.1	1.9	1.8	2.8	9.1	10.5	6.2	4.6	5.2	1.8-10.5
T Corrects	3	0.5	0.3	0.8	0.3	0.2	0.3	0.1	0.1	0.6	0.4	0.5	.2	0.3	0.2	0.4	0.3	0.3	0.1- 0.8
T Reprimands	4	0.1	0.3	1.0	0.6	0.3	0.4	0.5	0.2	0.3	0.4	0.7	1.6	0	0	0.7	0.1	0.4	0 - 1.6
T Demonstrates	5	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2	3.7	0	0.2	0 - 3.7
T's Infor Unc	6U	0.4	0.6	0.3	0.4	0.1	0	2.3	1.0	0.1	0.1	0	0.1	2.7	1.3	1.2	2.0	0.8	0 - 2.7
T Defines	6D	7.1	7.4	0.6	2.1	6.1	6.4	4.7	7.6	7.4	11.6	7.9	7.1	5.0	4.4	9.3	6.2	6.2	0.6-11.6
T Gives Facts	6F	15.7	13.7	8.2	16.3	22.0	18.2	23.4	18.1	24.3	29.0	25.4	24.7	10.1	19.8	17.1	22.6	18.6	8.2-29.0
T Explains	6X	18.4	16.6	7.3	6.1	19.1	16.4	18.0	23.0	25.1	19.3	23.5	15.2	3.1	4.2	3.5	11.6	14.1	6.1-25.1
T Gives Eval	6E	4.3	3.7	5.0	8.6	4.1	3.6	5.2	6.4	2.0	0.8	3.1	4.2	1.3	0.8	2.2	2.8	3.5	0.8- 8.6
T Nat Sci	6N	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0.3	0	0 - 0.3
T Lacks Info	6L	0.2	0.2	0.4	0.8	0.6	0.3	0.5	1.0	0.6	0.6	0.2	1.1	0	0	0.6	0.7	0.5	0 - 1.1
Sum of Cat 6	6+	46.1	42.6	22.8	34.3	52.0	44.9	54.1	57.1	59.5	61.4	60.3	52.7	22.5	21.0	34.1	46.5	44.1	21.0-61.4
T Lab Direct	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T Cautions	7C	0	0.3	0	0.1	0.3	0.3	0	0.1	0.1	0	0.1	0.8	1.8	2.1	0	0.2	0.4	0 - 2.1
T Suggests	7S	0	0	0	0	0	0	0	0	0	0.1	0.1	0.4	0	0.1	0	0.1	0	0 - 0.4
Sum of Cat 7	7+	0	0.3	0	0.1	0.3	0.3	0	0.1	0.1	0.1	0.2	1.2	1.8	2.2	0	0.3	0.5	0 - 2.2
T's Ques Unc	8U	0.9	1.2	0.4	0.1	0	0	0.9	0	0	0	0	0	1.0	0.2	0	0.3	0.3	0 - 1.2
T Asks Def	8D	2.4	1.2	3.2	1.1	0.9	0.9	2.1	1.3	1.5	1.6	0.2	1.5	3.8	3.6	5.8	1.8	2.1	0.2- 5.8
T Asks Facts	8F	3.7	3.5	4.8	4.7	1.9	3.3	2.0	1.0	0.5	0.8	1.2	1.7	5.8	6.5	4.4	2.4	3.1	0.5- 6.5
T Asks Expl	8X	8.7	6.9	6.7	3.7	6.6	6.4	4.5	5.4	3.5	2.9	2.9	3.8	7.1	7.9	0.6	4.6	5.2	0.6- 8.7
T Asks Eval	8E	1.5	1.0	2.5	3.5	0.7	1.5	1.1	0.6	0	0.2	0	0.1	1.2	1.2	0.1	0.3	0.9	0 - 3.5
T Nat Sci	8N	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 - 0.2
T Asks Prob	8P	0	0.7	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0 - 0.7
Sum of Cat 8	8+	17.2	14.7	17.6	13.1	8.1	12.1	10.6	8.4	5.5	5.5	4.3	7.1	19.0	19.6	11.3	9.5	11.8	4.3-19.6

TABLE 9 (CONTINUED)

Category		Teacher and Class Number																	
		11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Ave.	Range
T Looks	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T Asks Proc	10	1.5	1.4	4.6	2.7	1.7	1.2	2.2	1.8	1.2	0.7	3.2	4.4	2.5	3.8	1.9	2.5	2.4	0.7- 4.6
T Rout Dir	11	9.2	11.5	12.8	9.8	9.3	8.3	8.7	7.4	16.5	15.0	11.8	11.8	12.5	10.5	7.8	8.3	10.8	7.4-16.5
T Routines	12	2.0	2.9	0.3	0.2	0.1	0	0.1	1.5	0.5	1.3	0	0	2.3	1.0	0.7	2.3	1.0	0 - 2.9
T Supervises	13	0	0	0.9	0	0	0	0	0	0.3	0	0	0	0	0	0	0.3	0.1	0 - 0.9
P's Ques Unc	14U	0.2	1.1	0.5	0.7	0.6	0.6	1.2	1.4	0	0.2	0.4	0.2	1.6	0.9	1.1	1.2	0.7	0 - 1.6
P Asks Def	14D	0.2	0.2	0	0.1	0.2	0.6	0	0.2	0.2	0.1	0.2	0.3	0	0	0.4	0	0.2	0 - 0.6
P Asks Facts	14F	0.2	0.4	0.1	0.5	1.2	0.9	0	0.7	0	0.6	2.8	0.8	0.1	0	0.4	0.5	0.6	0 - 2.8
P Asks Expl	14X	0.2	0.6	0.1	0.7	0.6	1.8	0.1	1.2	0.1	0.1	1.0	0.3	0	0	0	0.4	0.4	0 - 1.8
P Ask Eval	14E	0	0.1	0.1	0.2	0	0.3	0	0.2	0	0	0.1	0	0	0	0	0.2	0.1	0 - 0.3
P Nat Sci	14N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P Seeks Asst	14A	0.4	0.9	0.8	0.8	0.4	0.4	0.7	1.2	0.5	0.8	0.5	0.2	0.3	0	0	0	0.5	0 - 1.2
Sum of Cat 14	14+	1.2	3.3	1.6	3.0	3.0	4.6	2.0	4.9	0.8	1.8	5.2	2.2	2.2	1.1	2.1	2.5	2.7	0.8- 5.2
P's Info Unc	15U	0.4	1.1	2.6	4.6	1.3	1.4	3.4	1.3	0.2	1.0	0.2	0.7	2.5	0.5	0.4	2.8	1.5	0.2- 4.6
P Defines	15D	1.3	0.9	3.2	1.4	1.0	1.3	1.2	1.1	1.2	0.7	0.3	0.6	3.0	3.3	8.6	1.4	1.9	0.3- 8.6
P States Facts	15F	2.1	2.8	5.3	6.4	2.5	3.6	1.0	1.1	0.6	0.6	1.8	1.3	4.9	5.5	10.2	1.6	3.2	0.6-10.2
P Explains	15X	4.8	4.7	6.6	6.0	6.3	7.4	2.2	2.7	2.5	1.2	2.1	1.7	10.3	14.4	1.7	7.9	5.4	1.2-14.4
P Gives Eval	15E	1.0	1.2	2.9	4.6	1.2	1.8	0.9	0.6	0	0	0.1	0	0.9	0.6	0	0.3	1.0	0 - 4.6
P Nat Sci	15N	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 - 0.6
P Lacks Info	15L	0	0	0.4	0.2	0	0	0	0	0	0.2	0	0	0	0	0.1	0	0	0 - 0.4
P Gi Prob Solv	15P	0	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0 - 0.3
P Gi Rt Info	15R	0.1	0.6	2.3	2.1	0.5	0.9	0.3	1.0	1.0	1.2	1.1	1.1	0.6	0.6	0.7	0.1	0.9	0.1- 2.3
Sum of Cat 15	15+	9.7	12.2	23.3	25.3	12.8	16.4	9.0	7.8	5.5	4.9	5.8	5.8	22.4	25.3	22.1	14.4	14.3	4.9-25.3
Silence	16	3.5	2.1	4.2	2.2	2.9	3.1	5.4	4.4	3.9	4.6	4.6	7.7	4.0	2.9	7.0	7.0	4.4	2.1- 7.7
N		2009	2089	2189	1952	2043	2206	1535	1657	2305	1826	1820	2335	2325	2061	1899	2780	2068	

a/ Figures = % of total observations in 4 lecture-discussion periods per class.

TABLE 10

SELECTED DIMENSIONS OF TEACHER-PUPIL INTERACTION IN 16 BIOLOGY CLASSES a/

Dimension or Sub-Dimension	Teacher and Class Number																	
	11	12	21	22	31	32	41	42	51	52	61	62	71	72	81	82	Ave.	Range
T. Eval. Dimension Categories 1 to 4	7.5	7.3	11.5	7.9	5.9	7.5	5.6	5.4	4.7	3.7	4.1	6.8	10.2	11.6	8.5	6.9	7.2	3.7-11.6
T. Sub. Info-Giving Categories 5 to 7	46.6	43.2	22.1	34.8	52.8	45.6	54.9	57.6	59.9	61.9	60.7	53.9	24.5	24.5	37.9	47.0	44.9	22.1-61.9
T. Sub. Info-Seeking Categories 8 and 9	17.5	15.1	17.8	13.3	10.4	12.4	10.9	8.5	5.6	5.7	4.4	7.2	19.1	19.7	11.4	9.6	11.9	4.4-19.7
T. Cog. Dimension Categories 5 to 9	64.1	58.3	39.9	47.1	63.2	68.0	65.8	66.1	65.5	67.6	65.1	61.1	43.6	44.2	49.3	56.6	56.8	39.9-68.0
T. Procedural Categories 10 to 13	12.9	15.9	18.8	12.8	11.2	9.5	11.2	10.8	18.7	17.1	15.0	16.2	17.4	15.4	10.5	13.6	14.3	9.5-18.8
T. Total Talk Categories 1 to 13	84.5	81.5	70.2	67.8	80.3	85.0	82.6	82.3	88.9	88.4	84.2	84.1	71.2	71.2	68.3	77.1	78.3	67.8-88.9
P. Info-Giving Category 15	10.3	12.7	23.7	25.7	13.2	16.8	9.5	8.0	5.9	5.1	5.9	5.9	22.4	25.4	22.2	14.5	14.4	5.1-25.7
P. Info-Seeking Category 14	1.7	3.5	1.9	3.2	3.4	4.9	2.4	5.2	1.1	1.9	5.2	2.2	2.2	1.1	2.1	2.6	2.7	1.1- 5.2
P. Total Talk Categories 14 and 15	12.0	16.2	25.6	28.9	16.6	21.7	11.9	13.2	7.0	7.0	11.1	8.1	24.7	26.5	24.3	17.0	17.1	7.0-28.9
Silence Category 16	3.4	2.0	4.1	2.0	2.7	3.0	5.2	4.2	3.8	4.5	4.5	7.5	3.9	2.8	7.0	6.9	4.3	2.0- 7.5
N	2009	2089	2189	1952	2043	2206	1535	1657	2305	1826	1820	2335	2325	2061	1899	2780	2068	

a/ Figures = % of total observations (N) in each class.

Pupil-Talk

In marked contrast, total pupil-talk accounted for about 17% of class time in the average class and ranged from 7 to 33% in the sixteen classes. The reader is reminded that informal pupil-talk -- pupil whispering, joking, socializing and talking -- was not included under pupil-talk. The observer's subjective impression was that such activity was present in almost all the classes observed and was especially noticeable in some. Also since there was relatively little direct discussion and exchange of ideas between pupils it would be fairly accurate to state that the pupil-talk was primarily addressed to the teacher.

Silent Pauses

Silent Pauses during interaction, essentially between teacher statements and less often between questions and answers accounted for about 4% of the time in the average class. Silent Pauses ranged from 2 to 7.5% of the time in the sixteen classes.

High student involvement in discussion and questioning is generally advocated or assumed to be important for inducing problem-solving, inquiry, critical thinking, etc. In fact, the teachers observed in this study stated that they used the "discussion method" more often than the "lecture method" and that they "don't do much lecturing". The data obtained in this study indicate that except for a few classes there was relatively little discussion and questioning by students. Differences between what teachers think they do or say they do and systematic, firsthand, objectively observed behavior will be noted a number of times in this report. Similar findings have been reported by other workers also. Flanders (11) for example, has pointed out the value of the need for objective non-evaluative feedback to teachers. The writer is persuaded by Flanders' description of the potential use of interaction analysis in pre-service and in-service training of teachers.

The Major Dimensions of Teacher Behavior

The average teacher devoted varying amounts of time to the three major dimensions of teacher behavior: Evaluative Dimension 7%, Cognitive Dimension 57%, and Procedural Dimension 14% (See Table 10). In the ensuing paragraphs, the major dimensions of classroom behavior will be discussed more or less separately while keeping in mind that these dimensions are inter-related. The order of presentation closely parallels the order in which the categories are listed. The reader may find it helpful to refer to the outline of the category system from time to time (see Appendix A). The reader should also note that abbreviated names of the categories are used in discussion but these names refer to the whole range of behaviors subsumed under that category.

The Evaluative Dimension

As shown in Table 10, teachers devoted about 4 to 12% of class time to the Evaluative Dimension with an average of about 7%. A more detailed study of the various categories comprising the Evaluative Dimension as shown in Table 9 indicates that the average teacher devoted most of the time, about 5%, in accepting pupil responses (category 2) and very little time (1%) in motivational aspects such as praising, accepting feeling, etc. included in category 1.

Correcting and qualifying pupils' responses (category 3) and reprimanding pupils for misbehavior (category 4) accounted for less than 1% of the time in the average class. A "high" score in category 3 could be an indication that pupils' substantive responses were not meeting the teacher's expectations, while a "high" score in category 4 could be an indication of teacher dissatisfaction with pupils' social conduct. Hence, it appears that in general the substantive and social behavior of pupils in the average biology class meets the teacher's standards.

The evaluative function is almost entirely performed by the teacher. A pupil is seldom called upon to overtly evaluate his own responses or those of other pupils and practically never called upon (or dares?) to overtly evaluate the teacher's definitions, descriptions, explanations, judgments, etc. Bellack and Associates (8) have reported similar findings in their study of high school social studies teachers. Engaging pupils more actively and consciously in the evaluative role would probably require a major change in conceptualization of teacher-pupil roles. The author is tempted to venture the hypothesis that a marked shift in classroom climate could occur by decreasing pupil dependence on the teacher for evaluation of pupil contributions in the classroom. The possibilities for research involving well conceived deliberate change in "the rules of the classroom game" are indeed intriguing.

Cognitive Dimension

As shown in Table 10, the major portion of teacher's talk was devoted to cognitive or rather substantive aspects, ranging from 40 to 68%. The average teacher spent 57% of class time in the Cognitive Dimension, of this, about 45% was spent in information-giving (categories 5, 6 and 7) and about 12% in information-seeking (categories 8 and 9). A more detailed study of the categories comprising the information-giving and information-seeking sub-dimensions can be made from Table 9 as stated below.

The average teacher spent very little time, about 0.2%, in giving any demonstrations (category 5). Examination of the scores for category 5 shows that only two of the eight teachers spent time in demonstrations.

The average teacher used four quasi-logical operations in giving substantive information, in the following decreasing order of occurrence: Fact-Stating (6F) 19%, Explaining (6X) 14%, Defining (6D) 6%, and Evaluating (6E) 4%.

The average teacher used four quasi-logical operations in seeking substantive information, in the following decreasing order of occurrence: asking for explanations (8X) 5%, asking for facts (8F) 3%, asking for definitions(8D) 2% and asking for evaluation of subject matter (6E) 1%.

Explicit references to or questions about the nature of science (teacher categories 6N and 8N and corresponding pupil categories 14N and 15N) and teachers' statements regarding the limitations of scientific and/or personal knowledge (6L) were virtually absent, less than 0.1% of the total time.

Problem-solving behaviors (categorizeable under 7S, 8P and 15P) occurred infrequently -- about 0.2% of the total time.

The wide discrepancy between exhortations to teach the Nature of Science, to engage in problem-solving, to teach sciences as inquiry, etc. and observed classroom practice in biology classes is striking.

The reader may recall that most of the teachers observed in this study have been participants in in-service institutes supported by the N.S.F. and other agencies. It has often been claimed that these institutes not only "up-date" the teacher's content background but prepare teachers to teach the Nature of Science. Parakh (23), Snider (35), and others have also reported evidence to indicate that the Nature of Science is seldom taught in science classes. If we are agreed (as we generally seem to be) that a major objective is to teach the Nature of Science then more than exhortations and platform speeches will be needed.

Procedural Dimension

As shown in Table 10, about 10 to 19% of total time was devoted to the Procedural Dimension of classroom life in the sixteen classes. The average teacher spent 14% of total time in the Procedural Dimension (categories 10 to 13). As shown in Table 9, about 11% out of the 14% was spent in category 11, giving procedural directions, assignments, etc., about 2% in category 10, asking questions related to classroom procedures, and about 1% in category 12, passing out papers, taking attendance, etc.

The sheer magnitude of the time devoted to procedural behaviors (almost the same as total pupil-talk) indicates a need for careful study of an aspect of classroom behavior that has generally received little attention in many category systems. It seems quite likely that the ways in which classroom routines are managed would have some effect on the affective and cognitive climate of the classroom. For instance, explicating transitions from topic to topic could make considerable difference in the organization and structure of a lesson or series of lessons.

Pupil-Talk Dimension

Pupil-talk was primarily addressed to the teacher and accounted for 17% of total time in the average class. Pupil questions accounted for about 3% and pupil responses accounted for about 14% of total time.

The reader is reminded that the "scores" for pupil-talk referred to in this section were obtained by using the Teacher-Pupil Interaction Analysis System (Appendix A) and not the Verbal Pupil-Behavior Category System (Appendix B). While the scores are related they are not identical because the scores in this section are based on a time unit and not actual numbers of utterances. Also, before considering the various sub-categories, it should be noted that much of the pupil-talk was extremely difficult to hear and consequently greater inference was used in categorizing on the basis of partially audible questions and responses, as described in the ground rules of the teacher-pupil interaction system. Hence, the writer feels less confident than he would wish to be about the frequencies of the various sub-categories of pupil-talk reported in Table 9 and described below.

Four quasi-logical operations were used by pupils in the average class in seeking substantive information in the following order of occurrence: asking for facts 0.6%, asking for explanation 0.4%, asking for definitions 0.2% and asking for evaluations 0.1% of total time. The relatively high figure of 0.7% in category 14U, i.e., questions unclassifiable in the other categories, is primarily due to inaudibility of pupil questions from the taperecordings.

Four quasi-logical operations were used by pupils in the average class in giving substantive information in the following order of occurrence: Explaining 5.4%, Fact-Stating 3.2%, Defining 1.9%, and Evaluating 1.0%. Again the relatively high score of 1.5% in category 15U is primarily due to inaudibility of pupil responses recorded on tape.

The Exchange of Substantive Information

In the preceding sections the giving and seeking of substantive information by the average teacher and his class of pupils was described as essentially taking place via the four quasi-logical operations, defining, fact-stating, explaining and evaluating. How these operations are inter-related and how the alternating of teacher-talk and pupil-talk occurs in certain sequences and patterns will be described in detail in the two sections following this one. However, for the moment by disregarding whether the teacher or pupil is the speaker or whether information is being given or solicited we can introduce a more inclusive concept of substantive information-exchange. The concept of substantive information-exchange allows one to get an overall picture of the relative frequency with which the four quasi-logical operations are performed in the class. Hence, if the relative frequencies for all definitions given and solicited by teacher and pupils are summed, i.e., sum of 6D, 8D, 14D and 15D gives the total amount of time spent in definitional exchanges. The total amount of time spent in factual and descriptive exchanges is obtained by summing scores on 6F, 8F, 14F and 15F, and so on for explanatory and evaluative exchanges. By summing the relevant figures in Table 9 it was found that in the average class the relative frequencies of four kinds of substantive information-exchange were as follows: factual exchanges 26%, explanatory exchanges 25%, definitional exchanges 11% and evaluative exchanges 6% of total class time. Moreover, these four kinds of exchanges account for about two-thirds or 68% of total class time and factual and explanatory exchanges take up approximately equal amounts of time and account for about half or 51% of class time.

The concept of informational exchanges raises some interesting questions for research such as: What is the relationship, if any, between the amount of time spent on specific kinds of informational exchange (say explanatory exchanges) and the score on the corresponding items on a test (say items testing for cause and effect relationships, comparisons, etc.)? Such an approach may prove to be more fruitful than the commonly employed one of using total achievement scores which are a composite of varying proportions of items testing various kinds of knowledge, understanding, etc.

General Sequences and Patterns of Teacher-Pupil Interaction

While the various percentage scores presented in Tables 9 and 10 give an indication of the relative amount of time spent in various categories of classroom behavior they do not indicate the sequential nature of classroom behavior nor the linking of certain sequences to form characteristic patterns of interaction. Behavioral sequences and patterns are probably best studied by using the techniques of matrix analysis. Detailed discussion of the technique may be found in the work of Flanders (12, 13) and Parakh (29). The general or more or less global patterns will be described by using the 16 X 16 interaction matrix (Table 11) and a more detailed or specific description of the most common pattern of teacher-pupil interaction will be obtained from the 31 X 31 interaction matrix (Table 13).

The most striking entry in 16 X 16 composite interaction matrix (Table 11) was that 34% of all entries (or 340 tallies per 1,000) were in the 6-6 cell, indicating sustained substantive information-giving or "lecturing". At various times the average or composite teacher stopped lecturing (1) to ask substantive and procedural questions, as indicated by entries of 3.3% and 0.7% in cells 6-8 and 6-10 respectively; (2) to give procedural directions, explicate transition from one topic to another, give orientation etc. as indicated by the entry of 2.2% in the 6-11 cell; (3) to pause silently (1.1% in 6-16 cell). On relatively rare occasions, (0.2% in 6-1 cell) the teacher punctuated his lecturing by joking, accepting pupils' feeling, reducing tension or praising pupils. Also on rare occasions (0.1% in 6-2 cell) the teacher punctuated his lecturing by a delayed acceptance of a response or contribution by one or more pupils.

Pupils interjected questions and comments during the average teacher's lecturing with approximately equal frequency as indicated by the figures 1.0% and 1.2% in the 6-14 and 6-15 cells respectively.

The cells formed by the intersection of each (horizontal) row with (vertical) column six indicate the behavioral events immediately preceding the teacher's lecturing or substantive information-giving behaviors. The most frequent teacher behaviors immediately preceding lecturing (other than previous lecturing) were those in rows (categories) 11, 2 and 8, namely, giving procedural information (2.3% in the 11-6 cell), accepting pupils responses (2.1% in the 2-6 cell) and the teacher's own questions (1% in the 8-6 cell).

The two kinds of pupil behavior that immediately preceded teacher's lecturing were of course pupils' questions and comments, 1.1% and 1.6% in the 14-6, and 15-6 cells respectively. However, the interaction between teacher and pupils may be viewed more easily by asking what did the teacher do, i.e., what teacher behaviors followed immediately after one or more pupils asked questions or gave information.

TABLE 11 16 X 16 INTERACTION MATRIX BASED ON 33,000 TALLIES IN 64 LECTURE-DISCUSSION PERIODS IN 16 CLASSES OF 8 BIOLOGY TEACHERS

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells
T. Praises Pupil(s) 1	2	.	.	.	.	1	.	1		.	1	.		.	3	1	2
T. Accepts P's Response(s) 2	.	2	.	.	.	21	.	19		1	3	.		1	4	1	2
T. Corrects P's Response(s) 3	.	.	.	.		2	.	1			.			.	1	.	5
T. Reprimands Pupil(s) 4	.			1		1		.		.	1	.		.	1	.	6
T. Demonstrates 5	.	.			1	.		.			.				.	.	8
T. Gives Substantive Info. 6	2	1	.	.	.	340	1	33	.	7	22	.		10	12	11	1
T. Gives Lab. Directions 7	.			.		1	2	.		.	.			.	.	.	6
T. Seeks Substantive Info. 8	1	.		.	.	10	.	31		1	4			1	63	7	4
T. Looks at P's Work 9																	16
T. Asks Procedural Ques. 10	.	.		.		3	.	1		3	4	.		2	8	2	4
T. Gives Procedural Direc. 11	1	.	.	1	.	23	1	10		3	45	2	.	4	9	9	1
T. Attends to Routines 12	.			.		.				.	2	7	.	.	.	.	6
T. Supervises 13								.		.	.		1	.		.	10
P. Seeks Information 14	.	1	.	.		11	.	1		2	5	.		4	1	1	3
P. Gives Information 15	3	47	3	1	.	16	.	15		4	11	.	.	2	39	2	1
Silence 16	1	.		1		11	.	5		2	8	.	.	1	3	10	3
Total In Each Category	11	52	4	5	2	441	5	119		24	108	10	1	27	144	43	78

Numbers are tallies per thousand, i.e., 10 x % of total tallies. Column totals contain slight errors due to rounding to nearest 0.1%. (The dots indicate entries less than .05%).
All subcategories have been pooled into their "parent" or major category.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

Such information is found in the cells formed by the intersection of rows, 14 and 15 with columns 1 to 13.

Questions by pupils were (predictably) followed most frequently by the teacher giving substantive and procedural information as indicated by 1.1% in the 14-6 cell (already stated above) and 0.5% in the 14-11 cell.

Pupils' questions were seldom followed by teacher questions, as indicated by the entries 0.1% and 0.2% in the 14-8 and 14-10 cells respectively. The average teacher hardly ever (0.1% or less) evaluated or reinforced pupil questions as can be seen from cells 14-1, 14-2, and 14-3. Thus pupils' questions were in general neither praised, accepted or modified. By contrast the average teacher on rare occasions did praise or did modify pupil-responses as indicated by the entries 0.3% in cells 15-1 and 15-3.

The most common teacher behavior immediately following pupil information-giving behavior consisted of teacher acceptance of pupils' responses, 4.7% in the 15-2 cell. Other teacher behaviors that immediately followed pupil responses were: lecturing, 1.6% in the 15-6 cell, substantive questions by the teacher, 1.5% in the 15-8 cell, and procedural directions by teacher 1.1% in the 15-11 cell.

Most pupil utterances lasted about five seconds or less as indicated by the proportionately larger entries in the transitional cells in columns 14 and 15 as compared with the entries in the steady state cells, 14-14 and 15-15, in columns 14 and 15. The reader may recall that transitional cells are formed by the intersection of unlike rows and columns (categories) and indicate a transition or shift from one category of behavior to another. The steady state cells are formed by the intersection of like rows and columns and indicate that the same category of behavior was repeated or occurred in two or more consecutive five-second intervals.

The amount of time spent by one or more pupils in sustained questioning and sustained information giving accounted for 0.4% (cell 14-14) and 3.9% (cell 15-15) of total time in the average class.

Pupil questions were immediately followed by pupil responses 0.1% of total time (14-15 cell), by the teacher about 2% of total time (sum of entries in cells 14-1 to 14-13) and by silent pauses 0.1% of total time (14-16 cell).

Pupil information-giving was immediately followed by pupil questions 0.2% of total time (15-14 cell), by the teacher about 10% of total time (sum of entries in cells 15-1 to 15-13) and by silent pauses 0.2% of total time (15-16 cell).

Silent pauses accounted for 4.3% of total time, silent pauses immediately followed teacher behavior about 3% of the total time as compared to 0.3% of the total time immediately after pupil-talk. Sustained silence lasting about 10 seconds or more lasted about 1% of total time. Silence immediately following teacher questions and pupil questions accounted for 0.7% and 0.1% of total time.

The most common pattern of teacher-pupil interaction can be extracted by linking the most frequently occurring related pairs of behaviors. In Table 12 the most common pattern of teacher-pupil interaction in the average class is shown. The figure in each cell has been taken from Table 11 (the 16 X 16 composite matrix).

The pattern shown symbolically as 6 → 8 → 15 → 2 → 6 → ... in Table 12 can be translated to provide a word "picture" or description. If an observer walked into the "average" biology lecture class, he would probably find the following pattern: The teacher would be giving substantive information or lecturing (6-6 cell). After a few seconds, or perhaps after a few minutes, the teacher would ask a short question lasting less than five seconds (6-8 cell). Sometimes the question would last longer than five seconds (8-8 cell). Most of the time a pupil would respond to the question by using a word or a phrase or a short sentence (8-15 cell). Occasionally, the pupil would respond for longer than five seconds (15-15 cell). Next, the teacher would give an evaluation of the pupil response, most often an acceptance or indication that the response was correct (15-2 cell). Following the evaluation, the teacher would give more substantive information (2-6 cell) and continue lecturing (6-6 cell) for the next few seconds or minutes. The reader may note that only 7 out of a total of 256 cells in the 16 X 16 matrix are used to describe the most common sequence of events and the entries in these 7 cells account for more than 57% of the total interaction. These events occurred repeatedly to form the dominant pattern. This basic pattern of information-giving and information-seeking may be summarized as follows: Teacher lectures for a relatively short period of time Teacher asks questions → Pupil responds → Teacher accepts response → Teacher lectures → ...

When the teacher responded to pupil response by behaviors other than acceptance (category 2) the following variations were most frequently found: 6 → 8 → 15 → 6, 6 → 8 → 15 → 8, and 6 → 8 → 15 → 11, i.e., pupil response followed by teacher giving substantive information, asking questions, and giving procedural directions, explicating transition of topics etc.

TABLE 12 THE MOST COMMON PATTERN OF TEACHER-PUPIL INTERACTION IN BIOLOGY LECTURE-DISCUSSION CLASSES

CATEGORY		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells
T. Praises Pupil(s)	1																	
T. Accepts P's Response(s)	2						21											
T. Corrects P's Response(s)	3																	
T. Reprimands Pupil(s)	4																	
T. Demonstrates	5																	
T. Gives Substantive Info.	6						340		33									
T. Gives Lab. Directions	7																	
T. Seeks Substantive Info.	8								31							63		
T. Looks at P's Work	9					Start Here												
T. Asks Procedural Ques.	10																	
T. Gives Procedural Direc.	11																	
T. Attends to Routines	12																	
T. Supervises	13																	
P. Seeks Information	14																	
P. Gives Information	15		47													39		
Silence	16																	
Total in Each Category																		

Figures in cells have been taken from Table 11. The pattern 6⟶8—15⟶2⟶6⟶.... is repeated a number of times and accounts for over 57% of total class time.

Specific Aspects of Teacher-Pupil Interaction

In the preceding section teacher-pupil interaction was described in somewhat global or general fashion using terms such as information-giving and information-seeking. For a closer or more detailed study of the most common pattern of interaction (6 → 8 → 15 → 2) and at the quasi-logical operations subsumed under the rubrics information-giving and information-seeking it is necessary to study the relevant cells in the 31 X 31 composite matrix presented as Table 13. The reader may recall that the 31 X 31 matrix contains the most commonly occurring sub-categories of 6, 8, 14 and 15.

The average teacher's sustained substantive information-giving behavior or lecture characteristically consisted of relatively unmixed (steady-state?) monologues of one of the four quasi-logical operations (D, F, X or E). Within the area or block of 25 cells formed by the intersection of rows and columns labelled 6+, 6D, 6F, 6X and 6E in Table 13 it can be seen that the three steady state cells, namely, 6D-6D (2.6%), 6F-6F (10.6%), 6X-6X (9%), constituted 22% out of the total of 34% or about two-thirds of the tallies in the 25 (6-6) cells. (The reader has probably noted that the above mentioned block of 25 cells constitutes a detailed representation of the 6-6 cell in Table 11).

About a third (12% out of the 34%) of the teacher's sustained substantive information-giving consisted of mixed (transitional?) monologues in which he shifted from one quasi-logical operation to another without interruption. Most frequently the teacher shifted from defining or explaining or evaluating to fact-stating as shown by the entries of 1.3%, 1.2% and 0.9% in the 6D-6F, 6X-6F, and 6E-6F cells respectively. From fact-stating the teacher shifted more or less equally often to defining and explaining, 1.3% and 1.7% in the 6F-6D and 6F-6X cells, and less often to evaluating, 0.8% in the 6F-6E cell.

The transition from lecturing to asking questions can be seen in the group of 25 cells formed by rows 6+, 6D, 6F, 6X, 6E and columns 8+, 8D, 8F, 8X and 8E in Table 13. There appeared to be a tendency for the average teacher to ask questions about the same kind of quasi-logical operation that he had used immediately preceding the question. For example, definition-giving, 6D, was followed more often by definition-seeking, (0.2% in the 6D-8D cell) than by fact-seeking (0.1% in the 6D-8F cell) or by explanation-seeking (0.1% in the 6D-8F cell) or by evaluation-seeking (less than 0.05% in the 6D-8E cell). An interesting exception to the above statement was found in that evaluation-giving, 6E, was not followed more often by evaluation-seeking (less than 0.05% in 6E-8E cells) but by fact-seeking (0.1% in 6E-8F cell) and by explanation-seeking (0.1% in the 6E-8X cell). However, in view of the relatively small frequencies in the various 6-8 cells these findings must be viewed as suggestive and needing replication.

TABLE 13 31 x 31 INTERACTION MATRIX BASED ON 33000 TALLIES IN 64 LECTURE-DISCUSSION PERIODS IN 16 CLASSES OF 8 BIOLOGY TEACHERS

CATEGORY		1	2	3	4	5	6+	6D	6F	6X	6E	7+	8+	8D	8F	8X	8E
T. Praises	1	2									1						
T. Accepts	2		2					3	8	8	2			5	5	7	1
T. Corrects	3								1								
T. Reprimands	4				1												
T. Demonstrates	5					1											
T. Gives Information	6+						4		2	1	1						
T. Defines	6D							26	13	6	2			2	1	1	
T. States Facts	6F	1					2	13	106	17	8	1		2	5	6	2
T. Explains	6X						1	6	12	90	5			1	2	6	1
T. Gives Evaluation	6E						1	1	9	6	8				1	1	
T. Gives Lab. Dir.	7+											3					
T. Seeks Info.	8+												1				
T. Asks Def.	8D							1						4			
T. Asks for Facts	8F								2						5		
T. Asks Expl.	8X								1	3	1					17	
T. Asks Eval.	8E																2
T. Looks P's Work	9																
T. Asks Proc. Ques.	10								1	1							
T. Gives Proc. Dir.	11	1			1		1	4	12	4	3	1	1	2	2	4	1
T. Attends Routines	12																
T. Supervises	13																
P. Seeks Info.	14+						2		2		1						
P. Asks for Def.	14D							1									
P. Asks for Facts	14F								3								
P. Asks for Expl.	14X									1							
P. Asks for Assist.	14A																
P. Gives Info.	15+	2	4		1		1	1	3	1	1				1	1	1
P. Defines	15D		10	1				1						1			
P. States Facts	15F		14	1					2	1					2	1	
P. Explains	15X		10	1			1		1	1					1	3	
Silence	16	1			1		1	2	3	2	1			1	2	2	
Total in Each Cat.		11	53	4	5	2	15	55	[illegible]	[illegible]	15	5	4	21	21	33	10

Numbers represent tallies per thousand, i.e., 10 × % of total tallies. Each cell represents a particular sequence of behavior. Read row first and column next, e.g., cell 15F-2 is read as P States Facts and T Accepts. (Cont'd.)

TABLE 13 (CONTINUED)

CATEGORY		9	10	11	12	13	14+	14D	14F	14X	14A	15+	15D	15F	15X	16	
T. Praises	1			1								2				1	
T. Accepts	2		1	3								1	1	1	2	1	
T. Corrects	3																
T. Reprimands	4			1								1					
T. Demonstrates	5																
T. Gives Information	6+		1	1			1					1			1	1	
T. Defines	6D		1	4									1			3	
T. States Facts	6F		3	8			1		1	1		2		2	1	4	
T. Explains	6X		2	6			1		1	1		1			1	3	
T. Gives Evaluation	6E		1	3								1				1	
T. Gives Lab. Dir.	7+																
T. Seeks Info.	8+											2					
T. Asks Def.	8D			1									13			1	
T. Asks for Facts	8F			1										18		2	
T. Asks Expl.	8X			2								1			23	3	
T. Asks Eval.	8E											6					
T. Looks P's Work	9																
T. Asks Proc. Ques.	10		3	4			1					6		1	1	2	
T. Gives Proc. Dir.	11		3	45	2		1				2	5	1	1	2	9	
T. Attends Routines	12			2	8												
T. Supervises	13					1											
P. Seeks Info.	14+		1	1			1										
P. Asks for Def.	14D																
P. Asks for Facts	14F								1								
P. Asks for Expl.	14X									2							
P. Asks for Assist.	14A			3													
P. Gives Info.	15+		2	7								6			1	1	
P. Defines	15D			1									2	1			
P. States Facts	15F		1	1									1	7			
P. Explains	15X		1	2			1					1			19		
Silence	16		2	8			1				1	1		1	1	10	Total
Total in Each Cat.			24	108	11	1	9	2	6	5	5	37	20	33	54	43	1000

There were virtually no tallies (less than 1 in 1000) in 13 sub-categories and the "residual" category (No. 17). In the interest of economy and clarity of presentation these sub-categories were pooled into their "parent" or major category thereby reducing the size of the matrix from 45x45 to 31x31. The pooled categories are 6+, 7+, 8+, 14+ and 15+.

When the teacher's questioning behavior lasted about ten seconds or longer, he used only one kind of quasi-logical operation within an utterance. In other words, the teacher seldom (less than 0.5%) asked for say a definition and a fact or a fact and an explanation when seeking information. Thus, the 3.1% noted in the 8-8 cell in the 16 X 16 matrix (Table 11) is seen in the 31 X 31 matrix (Table 13) as 2.9% in the five steady state cells and is composed of 0.1% in the 8+ - 8+ cell, 0.4% in the 8D-8D cell, 0.[illegible]% in the 8F-8F cell, 1.7% in the 8X-8X cell and 0.2% in the 8E-8E cell.

The next transition in the pattern, i.e., from teacher questions to pupil responses is shown in Table 13 in the 20 transitional cells formed by rows 8+, 8D, 8F, 8X, 8E and columns 15+, 15D, 15F, 15X (owing to the relatively small proportion of evaluative responses by pupils (15E) these were pooled into 15+). It is quite evident that the pupils' responses, which usually lasted five seconds or less, were almost always the same quasi-logical operation as solicited by the teacher, thus teacher's requests or questions for definitions, facts, explanations, etc. were responded to with definitions, facts, explanations with little or no movement from one kind of quasi-logical operation to another. Thus the 6.3% noted in the 8-15 cell in the 16 X 16 matrix (Table 11) is seen in the 31 X 31 matrix (Table 13) as 5.6% in four cells and is composed of 0.2% in the 8+ - 15+ cell, 1.3% in the 8D-15D cell, 1.8% in the 8F-15F cell, and 2.3% in the 8X-15X cell.

Sustained pupil responses (lasting about 10 seconds or more) are shown in the 16 cells formed by rows and columns labelled 15+, 15D, 15F and 15X in Table 13. Again there was a predominance of unmixed responses. Thus the 3.9% in the 15-15 cell in the 16 X 16 matrix (Table 11) is seen in the 31 X 31 matrix (Table 13) as 3.4% in the four steady state cells and is composed of 0.6% in the 15+ - 15+ cell, 0.2% in the 15D-15D cell, 0.7% in the 15F-15F cell, 1.9% in the 15X-15X cell.

The detailed examination of the first three links (6→8→15...) in the pattern of classroom interaction suggests that the average teacher structures and directs the discourse within specific quasi-logical operations or within well prescribed channels. Many of the teacher's questions were so highly structured that often the student needed to give only a word or phrase or at most a short sentence. To use an analogy to written objective questions such as true-false, multiple-choice and fill in the blank, the pupil had to "verbally fill in the blank".

The next step in the pattern, the teacher's evaluation of pupil responses is shown in the 12 cells formed by rows 15+, 15D, 15F, 15X and columns 1, 2 and 3 in Table 13. The teacher's evaluation consisted almost entirely of accepting the pupil's response as shown by the entries 0.4% in the 15+ - 2 cell, 1.0% in the 15D-2 cell, 1.4% in the 15F-2 cell and 1.9% in the 15X-2 cell. These "acceptance scores" are in approximately the same proportion as pupil responses in categories 15D, 15F and 15X. Pupil responses were very rarely corrected or qualified as shown by the entry of 0.1% in cells 15D-3, 15F-3 and 15X-3. This lends support to the notion that the pupils' responses were satisfactory to the teacher or that the pupil had "given" what the teacher had "asked for.

After accepting pupils' response the teacher resumed lecturing, most often by giving facts or explanations (0.8% in the 2-6F, and 2-6X cells) and less frequently by giving definitions, 0.3% in the 2-6D cell, or by giving evaluation or subject matter, 0.2% in the 2-6E cell.

The rather detailed description provided above may be viewed as a descriptive model of teacher-pupil interaction in the average or composite classroom. At the risk of belaboring the point, the writer wishes to emphasize that the patterns discussed above are not meant to be prescriptive but merely descriptive.

Comparison of Teacher-Pupil Interaction in Two Classes Taught by the Same Teacher

Teacher-pupil interaction in two classes each of the eight teachers observed in this study will be compared in two ways. By comparing the percentage of total class time spent in each category and by a cell by cell comparison of the entries in the interaction matrices. The Scott coefficient of agreement was computed as described by Flanders (13), and used as a measure of the similarity of scores on each category between two classes taught by a teacher. The Darwin Chi-Square statistic was used as an index of the homogeneity of the 16 X 16 matrices of the two classes taught by each teacher. The Darwin statistic was computed from the entries in each cell of the appropriate interaction matrix as described by Flanders (13). The Darwin Chi-Square is a much more microscopic measure of homogeneity than the Scott coefficient. The greater the agreement between the scores of two classes on each category the higher the Scott coefficient. Scott values lie between zero and one, the latter indicating perfect agreement. In contrast, the lower the Chi-square value the greater the similarity or homogeneity of matrices, with a Chi-square of zero indicating perfect agreement. Hence, one would expect high Scott values and low Chi-square values as indicators of good agreement. However, this relationship does not always hold as pointed out by Wightman and Snider (44) and caution needs to be exercised in rejection of the hypothesis of no difference between two matrices. More work needs to be done on the attributes of these two indices and on the comparison of interaction scores and matrices.

Category by Category Comparisons

The interaction scores on each category for the sixteen classes have been reported earlier in Table 9. Scott coefficients of agreement in class one versus class two of each of the eight teachers ranged from 0.4 to 0.9 as shown in Table 14. For five out of the eight teachers there was fairly high (0.7 or higher) agreement on the proportion of total time devoted to the several categories of behavior and for three teachers, numbers 2, 4 and 8 there was relatively lower agreement.

TABLE 14 SCOTT COEFFICIENTS AND DARWIN CHI-SQUARES OBTAINED FOR TWO CLASSES TAUGHT BY EACH BIOLOGY TEACHER

Statistic	Teacher Number							
	1	2	3	4	5	6	7	8
Scott Coefficient	0.8	0.5	0.8	0.6	0.7	0.7	0.9	0.4
Darwin Chi-square	139	239	104	130	165	201	132	249
No. of Empty Cells in 16 X 16 Summed Matrix	148	133	157	151	146	151	144	124

Values of Chi-square less than 277 (df 240) not significant at the 5% level.

A category by category comparison of scores of the three teachers 2, 4 and 8, who had Scott values of less than 0.7, revealed a number of differences which will be highlighted below. The reader may study the various figures in Table 9 as needed.

Teacher 2 who had one homogenously grouped average class, number 21, and one homogenously grouped high ability class, number 22, (see Table 9) devoted more than twice as much time in praising (category 1) and correcting pupil responses (category 3) in the average ability class than in the high ability class. He lectured about a third more of the time, (more time especially in defining and fact-stating) in the high ability class and spent somewhat less time asking questions in the high ability class. However, the pupils spent more time in the high ability class in asking questions and in responses.

In the two heterogenously grouped average ability classes of teacher number 4, the amount of time devoted to lecturing was approximately equal, especially in the amount of time devoted to fact-stating and explaining combined. However, in one class, number 41, he spent about 23% and 18% of the time in fact-stating and explaining (6F and 6X) and in the other class, number 42, he spent about 18% and 23% in fact-stating and explaining respectively. Teacher 4, also spent more time in lecturing and less time in asking questions in class number 42 than in class number 41. However, the pupils spent more time asking questions but less time giving responses in class number 42 than in class number 41.

Teacher 8 who had one homogenously grouped low ability class (number 81) and one average ability class (number 82) devoted considerably different amounts of time in about half of the categories shown in Table 9. Teacher 8 devoted proportionately more time in praising and encouraging pupil responses and in reprimanding pupils in the lower ability class. He spent considerably more time in giving demonstrations in the lower ability class. While he spent less time lecturing in the lower ability class he did give more emphasis to defining, somewhat less to fact-stating and considerably less to explaining. While the proportion of time he devoted to asking questions was about the same in both classes, he asked for considerably more definitions and facts and considerably fewer explanations in the lower ability class. The pupils in both classes of teacher 8 spent about the same proportion of time in asking questions but the pupils in the lower ability class spent a proportionately greater amount of time in giving information (the observer's notes indicated however, that the pupils in the lower ability class were asked to read aloud passages from the text).

In sum, careful examination of the interaction scores for each class revealed a number of differences in the behaviors in two classes taught by each teacher. However, a number of these differences do not appear to be systematic or to form any pattern and thus do not permit one to say that certain scores are characteristic of the various ability groups. However, a few differences in scores are suggestive and need to be examined by studies with more teachers and specifically directed to answer such questions.

Cell by Cell Comparisons of Matrices

Darwin Chi-square values obtained by comparing the 16 X 16 matrices for class 1 and 2 taught by each teacher are given in Table 14. If Chi-square was less than 277 the matrices were considered to be not significantly different at the .05 level (with 240 degrees of freedom). Hence, the null hypothesis of no difference between the matrix of class 1 versus matrix of class 2 could not be rejected at the .05 level for any of the eight teachers. Thus, the results of the (more microscopic) Darwin test indicated no significant difference while the (more macroscopic) Scott coefficients reported in the previous section indicated considerably less than perfect agreement on category scores for teachers 2, 4 and 8.

Wightman and Snider (44) have noted a similar discrepancy and in a technical study of the characteristics of the Darwin and Scott statistics have indicated that a "high number of zero cells in the summed matrix,"... (in this case the summed matrix of class 1 and 2) "does violence to the model as it was assumed by Darwin". Flanders (13) also has indicated that zero cells or empty cells tend to give unrealistically low values of Chi-square. Wightman and Snider (44) have pointed out that "Chi-square is directly meaningful only when there are no empty cells in a comparison" and have tentatively recommended subtracting one degree of freedom for every empty cell in the summed matrix in order to get a more meaningful approximation for the number of degrees of freedom. Accordingly the correction for degrees of freedom was tried. However, with this correction it was found that the null hypothesis of no difference between class 1 and class 2 could be rejected beyond the .005 level for six out of the eight teachers, beyond the 0.1 level for teacher 3 and beyond the .01 level for teacher 7. Hence, correcting for degrees of freedom as suggested (44) does not appear to solve the problem of discrepant interpretations based on the two measures. It would appear that some other correction factor should be used or some other test of significance which does not require the assumptions underlying the Darwin Chi-square be developed. However, for the purposes of this study, cell by cell comparisons can be made by inspection and provide insight into the differences in behavior sequences in two classes taught by each teacher. Accordingly, quantitative cell by cell comparisons are presented in Tables 15-22. The reader is urged to compare the entries in any of cells of special interest to him. A verbal description would be repetitious of the kind of description provided for the composite matrix (Table 11) in an earlier section.

TABLE 15 CELL BY CELL COMPARISONS OF 16 X 16 MATRICES OF TWO BIOLOGY CLASSES OF TEACHER #1

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells	TOTAL*
T. Praises Pupil(s) 1						 .5		.5 1		 .5	.5 .5	 .5			1 2		13 10	
T. Accepts P's Response(s) 2		4 3	.5 .5			28 32		21 13		1 .5	1 .5	 .5		2 1	5 5	1 .5	7 6	
T. Corrects P's Response(s) 3						2 .5		2 1						.5 	.5 1		12 13	
T. Reprimands Pupil(s) 4						.5 1		 .5			1 .5	 1			 .5	.5 .5	13 10	
T. Demonstrates 5																	16 16	
T. Gives Substantive Info. 6	.5 1	 2	.5 	 1		363 322	.5 .5	44 41		8 4	25 31			5 12	9 9	9 6	6 5	
T. Gives Lab. Directions 7						.5 1	.5 2										14 14	
T. Seeks Substantive Info. 8	.5 1	 .5		.5 		22 17	 .5	75 60			3 3			 1	67 64	6 4	9 7	
T. Looks at P's Work 9																	16 16	
T. Asks Procedural Ques. 10				 .5		2 1		 .5		1 .5	5 2			3 5	3 4	 .5	11 8	
T. Gives Procedural Direc. 11	 .5			1 .5		19 21		14 18		2 3	43 53	1 3		3 6	2 7	6 4	7 6	
T. Attends to Routines 12	 .5				 1	 .5				 1	1 1	19 23		 2		.5 	13 9	
T. Supervises 13																	16 16	
P. Seeks Information 14		2 2	.5 	 1		8 13		.5 2		.5 3	3 6			2 8	 .5	.5 	8 8	
P. Gives Information 15	.5 1	59 53	4 3	.5 		10 14	 .5	12 10		1 2	3 9	 .5		 .5	11 32	1 1	6 4	
Silence 16	.5 .5					8 5		6 3		.5 .5	5 5	1 .5		.5 1	4 1	8 3	7 7	
Total In Each Category	2 5	65 62	6 3	2 4	 1	465 428	1 4	175 151		15 14	92 116	21 29		17 35	103 127	34 20	174 155	998 998

Top and bottom numbers are for class 1 and class 2 respectively. Numbers represent tallies per thousand, i.e., 10 x % of total tallies*. Totals contain slight errors due to rounding.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

TABLE 16 CELL BY CELL COMPARISONS OF 16 X 16 MATRICES OF TWO BIOLOGY CLASSES OF TEACHER #2

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells	TOTAL*
T. Praises Pupil(s) 1	10		.5			1		5		1	5			.5	8	2	7	
	2					1		3			3				7	.5	10	
T. Accepts P's Response(s) 2		3	3	.5		15		23		1	6			.5	8	1	8	
		.5				22		13		3	4			2	9	.5	8	
T. Corrects P's Response(s) 3		.5				2		3			.5				1	.5	9	
	.5					2									2		13	
T. Reprimands Pupil(s) 4	2			4				2		.5	1				1		10	
	1			1		2		2			1				.5		10	
T. Demonstrates 5																	16	
																	16	
T. Gives Substantive Info. 6	4	1	1			140	.5	34		4	17			4	13	2	5	
	2	1	.5	.5		237	.5	42		8	13			12	28	3	4	
T. Gives Lab. Directions 7	.5					.5											14	
							.5							.5			14	
T. Seeks Substantive Info. 8	3	.5		1		6		41		5	8			2	97	14	6	
				1		13		17		3	5			3	87	6	8	
T. Looks at P's Work 9																	16	
																	16	
T. Asks Procedural Ques. 10	2	1		.5		1		3		5	6			.5	26	2	6	
				2		3		2			2			1	19		10	
T. Gives Procedural Direc. 11	2	.5	.5	3		14	.5	21		5	43	2	1	6	21	8	2	
	.5					20		9		4	30	.5		5	21	7	7	
T. Attends to Routines 12											.5	1		1		.5	12	
												1	1				14	
T. Supervises 13								.5		.5				8			12	
																	16	
P. Seeks Information 14	.5	1				5		.5		1	8			.5	1	1	7	
		1	.5			12		1		.5	11			4	2	.5	7	
P. Gives Information 15	8	53	3	.5		28		37		18	27		1	1	54	5	4	
	10	51	3	2		32		43		9	25			6	77	.5	5	
Silence 16	2			1		6		8		5	5			1	7	5	7	
				1		4		1		1	4	.5		.5	6	3	7	
Total In Each Category	35	61	8	10		220	1	178		46	129	3	10	19	237	41	139	998
	16	53	4	7		347	1	133		28	98	2		32	257	20	165	998

Top and bottom numbers are for class 1 and class 2 respectively. Numbers represent tallies per thousand, i.e., 10 x % of total tallies *. Totals contain slight errors due to rounding.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

TABLE 17 CELL BY CELL COMPARISONS OF 16 X 16 MATRICES OF TWO BIOLOGY CLASSES OF TEACHER #3

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells	TOTAL*
T. Praises Pupil(s) 1	2			.5		1		1			.5			.5	2	.5	8	
						2					1				4		13	
T. Accepts P's Response(s) 2		1				24		9			1			1	6	1	9	
	.5	5				24	1	14		1	2			2	10	.5	6	
T. Corrects P's Response(s) 3						2											15	
						2									1		14	
T. Reprimands Pupil(s) 4				1		.5					1				.5	.5	11	
				1		.5					1	.5			2		11	
T. Demonstrates 5																	16	
																	16	
T. Gives Substantive Info. 6		1		.5		413	1	32		8	22			16	21	8	5	
	.5					329	2	37		5	21			25	22	10	7	
T. Gives Lab. Directions 7						1	2									.5	13	
						2	1	1									13	
T. Seeks Substantive Info. 8						6		36		1	2			1	48	9	9	
	.5			.5		5		39			2			1	67	9	8	
T. Looks at P's Work 9																	16	
																	16	
T. Asks Procedural Ques. 10	.5					5		.5		1	2			1	6		9	
						4		1			1			2	5		11	
T. Gives Procedural Direc. 11	.5					24		6		2	42	1		4	9	5	7	
	2					21		6		1	33			4	8	7	8	
T. Attends to Routines 12										.5	.5	.5					13	
																	16	
T. Supervises 13																	16	
																	16	
P. Seeks Information 14	.5	1	.5			13		2		1	6			7	2		7	
	.5	1		1		22		3		3	5			11	3		7	
P. Gives Information 15	4	40	2	.5		23		12		4	11			1	32	1	5	
	3	53	3	2		28		19		3	12			2	40	2	5	
Silence 16	1			1		10		5			4			1	4	1	8	
		.5				13		4		5				1	5	1	9	
Total In Each Category	9	44	2	3		524	4	104		18	93	1		34	132	27	167	995
	7	59	4	5		452	4	124		13	83			49	168	30	176	998

Top and bottom numbers are for class 1 and class 2 respectively. Numbers represent tallies per thousand, i.e., 10 x % of total tallies *. Totals contain slight errors due to rounding.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

TABLE 18 CELL BY CELL COMPARISONS OF 16 X 16 MATRICES OF TWO BIOLOGY CLASSES OF TEACHER #4

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells	TOTAL*
T. Praises Pupil(s) 1	1 					1 		3 			1 1	 .5		1 .5	5 2	1 2	9 10	
T. Accepts P's Response(s) 2	1 	1 1				23 29		9 8			3 1				 1	1 .5	10 10	
T. Corrects P's Response(s) 3		1 				1 1									 .5		14 14	
T. Reprimands Pupil(s) 4	1 					1 .5					1 .5				2 1		12 13	
T. Demonstrates 5																	16 16	
T. Gives Substantive Info. 6	2 2	1 .5		1 .5		444 457	1 	40 37		5 4	19 20	1 		8 26	8 10	19 16	4 6	
T. Gives Lab. Directions 7							 .5				1 			 .5			15 13	
T. Seeks Substantive Info. 8	1 			1 		18 13		27 23		1 	1 1			2 2	51 42	7 4	7 10	
T. Looks at P's Work 9																	16 16	
T. Asks Procedural Ques. 10						3 4		1 		1 11	1 3			2 2	14 8	3 5	9 10	
T. Gives Procedural Direc. 11	1 1			2 		16 19	 .5	10 5		4 2	34 22	1 3		3 9	6 7	10 5	6 6	
T. Attends to Routines 12	 .5					1 .5					 3	1 7		 2	 2		14 10	
T. Supervises 13																	16 16	
P. Seeks Information 14	1 	 3				9 23		1 3		3 7	6 9	 .5		2 5	1 .5	1 2	8 7	
P. Gives Information 15	3 3	35 37	1 2	1 .5		16 10	 .5	10 5		6 2	7 7	 3		3 4	8 5	5 2	5 3	
Silence 16	1 .5	 .5		1 1		16 15		9 4		3 2	12 5	 .5		3 .5	1 1	6 10	7 5	
Total In Each Category	12 8	33 42	1 2	5 2		548 574	1 2	109 86		23 18	88 74	2 15		24 52	95 80	52 42	168 165	998 997

Top and bottom numbers are for class 1 and class 2 respectively. Numbers represent tallies per thousand. i.e., 10 x % of total tallies*. Totals contain slight errors due to rounding.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

TABLE 19 CELL BY CELL COMPARISONS OF 16 X 16 MATRICES OF TWO BIOLOGY CLASSES OF TEACHER #5

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells	TOTAL*
T. Praises Pupil(s) 1	3	.5				.5		.5			2				.5		10	
	.5					2		2			2			.5	2		10	
T. Accepts P's Response(s) 2		2				14		10		.5	2				2	1	8	
	.5	3				8		5		.5	1			2			9	
T. Corrects P's Response(s) 3						3		1						.5	2		12	
						1									.5		13	
T. Reprimands Pupil(s) 4				1						.5	.5				.5	1	11	
				.5		1				.5	.5				1	.5	10	
T. Demonstrates 5																	16	
																	16	
T. Gives Substantive Info. 6	.5	1	.5	.5		510		20		6	45			3	4	9	5	
	2	1	2	1		532	.5	13		2	49	.5		4	3	9	3	
T. Gives Lab. Directions 7						.5	.5	.5									13	
						.5	.5										14	
T. Seeks Substantive Info. 8	.5					3		13			2				33	5	10	
	.5					.5		26			2			1	21	5	9	
T. Looks at P's Work 9																	16	
																	16	
T. Asks Procedural Ques. 10				.5		.5		.5		.5	5	.5		1	5		8	
				1		5				1	1			.5	2	.5	9	
T. Gives Procedural Direc. 11	1			1		48	.5	1		2	89	2		4	5	11	5	
	1	.5				54		3		2	61	2		4	10	13	6	
T. Attends to Routines 12						1				1	.5	3	.5				11	
						1					3	9		.5			12	
T. Supervises 13											.5						14	
																	16	
P. Seeks Information 14		.5				2		.5		1	6			2	.5		9	
		.5	.5			4					9			4	.5	.5	9	
P. Gives Information 15	1	27	6			6		6		2	6			.5	3		7	
	3	14	2	1		7		3		.5	12			.5	8	1	5	
Silence 16						11		3			9	.5		1	1	11	9	
	.5	.5		.5		7		3		.5	11	2		2	3	15	5	
Total in Each Category	6	31	6	3		598	1	56		13	166	6	3	11	59	38	164	997
	8	20	4	4		617	1	57		7	150	14		19	51	45	162	997

Top and bottom numbers are for class 1 and class 2 respectively. Numbers represent tallies per thousand, i.e., 10 x % of total tallies*. Totals contain slight errors due to rounding.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

TABLE 20 CELL BY CELL COMPARISONS OF 16 X 16 MATRICES OF TWO BIOLOGY CLASSES OF TEACHER #6

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells	TOTAL*
T. Praises Pupil(s) 1	.5 11					2 3		.5		.5	3 1			1	.5 2	.5 3	8 8	
T. Accepts P's Response(s) 2		2	1			12 10		5		2	1 2			1			12 7	
T. Corrects P's Response(s) 3						3 1					1				1		13 12	
T. Reprimands Pupil(s) 4				3 7		1 1					4			1	.5 3	1 1	11 10	
T. Demonstrates 5																	16 16	
T. Gives Substantive Info. 6	3 2		.5	1		492 432	1 5	29 26		9 12	23 19			14 7	12 5	19 18	5 6	
T. Gives Lab. Directions 7						1 4	2 7				.5 1						13 11	
T. Seeks Substantive Info. 8				.5		9 12		5 23			2 3				25 26	2 7	10 9	
T. Looks at P's Work 9																	16 16	
T. Asks Procedural Ques. 10	.5					5 6				6 12	7 6			5 3	6 8	2 8	9 7	
T. Gives Procedural Direc. 11	2 3			1 3		30 23	1	2 3		6 6	58 54			6 3	5 5	9 16	7 6	
T. Attends to Routines 12																	16 16	
T. Supervises 13																	16 16	
P. Seeks Information 14	.5	2 1		.5 1		19 7				2 2	9 4			18 4	.5 1	2 2	7 6	
P. Gives Information 15	2 3	17 25	4 2	.5 2		11 3		1 1		4 1	4 12			4	8 6	4 3	5 6	
Silence 16	1			3		18 23	.5	2 6		5 8	10 14			3 3	.5 2	5 17	7 6	
Total In Each Category	9 20	19 28	5 3	7 17		604 526	3 13	44 72		32 44	118 118			52 22	59 59	45 75	171 158	997 997

Top and bottom numbers are for class 1 and class 2 respectively. Numbers represent tallies per thousand, i.e., 10 x % of total tallies*. Totals contain slight errors due to rounding.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

TABLE 21 CELL BY CELL COMPARISONS OF 16 X 16 MATRICES OF TWO BIOLOGY CLASSES OF TEACHER #7

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells	TOTAL*
T. Praises Pupil(s) 1	1					2	1	2		.5	1				1		9	
	1					.5	1	3		1	1				1		9	
T. Accepts P's Response(s) 2		2				29		48		3	6			.5	2	1	7	
		2				31	.5	59		4	4				3	1	8	
T. Corrects P's Response(s) 3			.5			1	.5	1									12	
						.5		1							.5		13	
T. Reprimands Pupil(s) 4																	16	
																	16	
T. Demonstrates 5						.5											14	
	.5							1			.5				.5		12	
T. Gives Substantive Info. 6	3	1				128	3	41		6	18			4	15	5	6	
	.5	.5				127	3	39	.5	11	13			3	11	3	5	
T. Gives Lab. Directions 7						2	9	2		1	2			1	1	1	8	
	1					2	10	2		2	2				1	1	8	
T. Seeks Substantive Info. 8	1	1			1	11		37		2	12			3	117	6	6	
	1				2	12	.5	34		1	11				131	3	7	
T. Looks at P's Work 9																	16	
																	16	
T. Asks Procedural Ques. 10						2		1		3	8			3	7		10	
	.5					4	2	5		4	8			4	9	1	7	
T. Gives Procedural Direc. 11	2		1		.5	21	3	26		2	44	3		3	11	9	4	
	.5					12	3	19		5	45	.5		1	12	8	6	
T. Attends to Routines 12						.5				.5	3	19					12	
											.5	10					14	
T. Supervises 13																	16	
																	16	
P. Seeks Information 14	.5	1				11	1	2		.5	4			2	1		7	
						6	.5	1		1	2						11	
P. Gives Information 15	.5	86	2			15	.5	24		4	20	1		4	67	1	4	
	3	103	2			15	1	26		6	11			1	84	.5	5	
Silence 16						3		6		2	8	.5		1	2	17	8	
						1	.5	5		2	7	1		1		9	7	
Total In Each Category	8	92	3		2	225	18	191		25	125	23		22	225	39	155	998
	9	105	2		2	211	22	197		38	105	11		11	254	28	160	995

Top and bottom numbers are for class 1 and class 2 respectively. Numbers represent tallies per thousand, i.e., 10 x % of total tallies*. Totals contain slight errors due to rounding.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

TABLE 22 CELL BY CELL COMPARISONS OF 16 X 16 MATRICES OF TWO BIOLOGY CLASSES OF TEACHER #8

CATEGORY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Empty Cells	TOTAL*
T. Praises Pupil(s) 1	1				.5	3 2		1 1		.5	2 .5			1	2 2	1 .5	9 9	
T. Accepts P's Response(s) 2		4 2	1		.5	13 21		31 14		2 2	9			.5 1	2 2	.5 3	6 8	
T. Corrects P's Response(s) 3	.5			.5 .5		3 2		.5 .5						.5	.5 .5		11 11	
T. Reprimands Pupil(s) 4				3 .5		.5 .5		2			1 1			.5	.5 .5	.5	9 12	
T. Demonstrates 5	.5	1			22	4		2 .5			1				7	.5	8 15	
T. Gives Substantive Info. 6	2 2	1 2	.5 .5	1	2	238 360	.5 1	31 31		5 13	11 13	2		15 12	15 10	17 20	2 5	
T. Gives Lab. Directions 7						.5 2	1	.5								.5	15 12	
T. Seeks Substantive Info. 8	2			.5	.5	9 9		19 18		.5	3 4				67 55	13 10	7 11	
T. Looks at P's Work 9																	16 16	
T. Asks Procedural Ques. 10	1			.5		3 5		1		.5 3	3 5	.5		2 2	7 4	2 4	7 8	
T. Gives Procedural Direc. 11	2			.5 1	6 .5	13 16	.5	5 9		3 2	26 32	1 7		1 1	11 4	10 10	5 5	
T. Attends to Routines 12						2					2 7	4 17			.5		12 14	
T. Supervises 13													3	.5		.5	16 13	
P. Seeks Information 14		.5 2	.5			16 16		.5 1		2 .5	1 2			.5 4	.5	.5 .5	8 7	
P. Gives Information 15	.5 2	55 40	3 3	1	6	20 10	.5	16 12		3 2	8 7	1		.5 2	102 64	4 2	3 5	
Silence 16	2 .5	.5 .5		.5 .5		17 22	.5	6 8		5 3	11 10		2 1	1 2	6 4	19 18	5 4	
Total in Each Category	10 6	62 46	5 4	8 2	38	341 465	1 4	114 96		19 26	77 83	8 24	2 4	21 26	222 145	70 69	139 155	996 1000

Top and bottom numbers are for class 1 and class 2 respectively. Numbers represent tallies per thousand, i.e., 10 x % of total tallies*. Totals contain slight errors due to rounding.
Read row first, column next, e.g., cell 15-3 is read as P Gives Information and T Corrects P's Response.

INTER-RELATIONSHIPS AMONG TEACHER BEHAVIORS, PUPIL BEHAVIORS, PUPIL CHARACTERISTICS AND PUPIL ACHIEVEMENT

In the ensuing sections the results of a preliminary exploration of some of the inter-relationships among four major sets or classes of variables are given. While the primary emphasis in this study has been on description of pupil behavior and secondarily on teacher behavior, the investigator felt that a small and perhaps informal beginning could be made in examining some inter-relationships among teacher behaviors, pupil behaviors, pupil characteristics and pupil achievement. The findings reported below are perhaps best viewed as leads to be followed up rather than as well established conclusions that can be generalized to all biology teachers or even to biology teachers of Central New York.

Relationships Between Teacher Behavior and Pupil Behavior

The techniques of interaction-matrix-analysis used earlier in this report brought out the most common pattern of teacher-pupil interaction and the variety of behavior sequences in the average biology class. In the following paragraphs the results of a preliminary correlational study will be presented. The Spearman coefficients of correlation (rho) shown in Table 23 were determined for twenty teacher behavior scores and fourteen pupil behavior scores selected from Table 9. A computer program was used and corrections for tied scores were made as described in Siegel (34). The reader may recall that Table 9 contains the relative frequencies of occurrence of various kinds of categories of teacher and pupil behavior in the sixteen classes observed in this study. These scores represent the percent of total time devoted to each category. A number of teacher and pupil scores were not selected because of the large number of zero or almost zero values and for these the assumption of linearity underlying the Spearman statistic could not be defended. The reader is also reminded that the pupil behavior scores are scores for the entire class of pupils rather than behavior scores of individual pupils.

Numerous null hypotheses were tested, these hypotheses were derived from the following general form:
H_o There is no relationship between teacher behavior T_b and pupil behavior P_b -- where T_b and P_b represent scores on various categories of teacher behavior and pupil behavior respectively.

Table 24 shows the correlations significantly different from zero at the .05 and .01 levels, i.e., the null hypothesis of no relationship was rejected. Only the significant rhos are shown in Table 24 so as to make the results more readily comprehensible. The complete set of rhos are given in Table 23.

TABLE 23 RELATIONSHIPS BETWEEN TEACHER BEHAVIORS AND PUPIL BEHAVIORS IN 16 BIOLOGY CLASSES a/

Teacher Behaviors	Pupil Behaviors													
	14U	14D	14F	14X	14E	14A	14+	15U	15D	15F	15X	15E	15R	15+
1	-01	-17	04	-18	-11	04	-03	24	10	26	-22	02	52*	23
2	38	-27	-50*	-40	-01	05	-28	19	82+	77+	71+	49*	-30	83+
3	-56*	07	-13	-19	-02	-15	-32	-39	14	10	-13	-08	33	-07
4	-38	34	31	15	09	-11	15	-01	-25	04	-60*	-06	64+	-16
6U	80+	-59*	-61+	-50*	-15	00	-21	39	56*	22	34	03	-52*	43*
6D	-24	60*	39	14	-10	-13	20	-66+	-50*	-43*	-71+	-67+	10	-70+
6F	-40	30	47*	26	-10	-26	17	-25	-71+	-75+	-67+	-61+	14	-81+
6X	-47*	29	31	45*	01	23	14	-39	-76+	-78	-48*	-25	08	-84+
6E	10	08	16	52*	39	18	32	46*	-13	01	-07	55*	12	06
6L	-07	24	36	31	21	-15	18	21	-23	-34	-41	-25	30	-29
6+	-40	25	41	37	-04	01	18	-28	-81+	-89+	-67+	-49*	15	-92+
7+	18	-04	22	08	03	-07	26	-00	-12	11	46*	-05	-15	16
8D	26	-43*	-73+	-89+	-51*	-16	-70+	-00	70+	26	15	-22	-25	34
8F	39	-36	-43*	-38	02	02	-19	32	79+	87+	65+	53*	-17	92+
8X	24	-30	-31	-07	-01	21	-14	20	29	29	74+	58*	-47*	44*
8E	23	-35	-27	05	28	29	-07	61+	50*	54*	64+	88+	-06	71+
8+	41	-38	-54*	-34	04	18	-25	34	73+	71+	69+	60*	-26	82+
10	17	-39	-09	-17	05	-02	-01	21	27	39	23	08	22	44*
11	-55*	-26	-22	-34	-37	19	-40	-25	-25	-19	-12	-16	48*	-24
12	42	-36	-40	-30	-04	13	-18	04	28	03	27	-03	-40	12

a/ Figures are Spearman Rank correlation coefficients

* Rho > .425 Significant beyond 5% level -- df = 14

+ Rho > .601 Significant beyond 1% level -- df = 14

Decimal points have been omitted

TABLE 24 SIGNIFICANT SPEARMAN COEFFICIENTS OF CORRELATION BETWEEN TEACHER BEHAVIORS AND PUPIL BEHAVIORS

Teacher Behaviors	Pupil Behaviors													
	14U	14D	14F	14X	14E	14A	14+	15U	15D	15F	15X	15E	15R	15+
1													52*	
2			-50*						82+	77+	71+	49*		83+
3	-56*													
4											-60*		64+	
6U	80+	-59*	-61+	-50*					56*				-52*	43*
6D		60*							-50*	-43*	-71+	-67+		-70+
6F			47*						-71+	-75+	-67+	-61+		-81+
6X	-47*			45*					-76+	-78+	-48*			-84+
6E				52*				46*				55*		
6L														
6+									-81+	-89+	-67+	-49*		-92+
7+											46*			
8D		-43*	-73+	-89+	-51*		-70+		70+					
8F			-43*						79+	87+	65+	53*		92+
8X											74+	58*	-47*	44*
8E								61+	50*	54*	64+	88+		71+
8+			-54*						73+	71+	69+	60*		82+
10														44*
11	-55*												48*	
12														

* Rho > .425 Significant beyond 5% level -- df = 14

+ Rho > .601 Significant beyond 1% level -- df = 14

Decimal points have been omitted

Inspection of Table 24 showed a clustering of significant rhos and suggests that the following overall relationships between teacher and pupil behavior existed in the observed classes.

Specific kinds or sub-categories of teachers' information-giving behavior or lecturing were positively and significantly correlated with the corresponding sub-categories of pupil questions --for example, 6D and 14D, 6F and 14F, 6X and 14X were positively and significantly correlated.

Specific kinds or sub-categories of teachers' information-giving behavior or lecturing were negatively and significantly correlated with almost all sub-categories of pupils' information-giving behavior --for example, 6D and 15D, 6D and 15F, 6D and 15X etc. were negatively correlated. Also, it was found that the total time spent in lecturing (6+) was negatively and significantly correlated with total time spent in pupil response (15+), a rho of -.92.

Teachers' questions about definitions (8D) were negatively and significantly correlated with almost all sub-categories of pupil questions and with total pupil questions (14+). Other categories of teachers' questions were generally negatively correlated with pupil questions as shown in Table 23.

Various sub-categories of teachers' questions were positively and significantly correlated with most sub-categories of pupil responses, and the correlations between specific sub-categories of teacher questions and the corresponding (isomorphic) sub-category of pupil responses were somewhat higher (see sub-categories of 8 and 15 in Table 24). Teacher praise was positively and significantly correlated with pupil responses, for example, 2 and 15D, 2 and 15F, etc.

In short, teachers' information-giving behavior (lecturing) was postively related to pupil questions but negatively related to pupil responses, while teachers' questioning or information-seeking behavior and acceptance of pupil responses was positively related to pupil responses. These findings are not surprising, however, the negative correlations between teacher questions and pupil questions is surprising or at least does not support the notion that the kinds of questions a teacher asks serve as a model for the pupils.

Relationships Between Pupil Characteristics and Pupil Behavior

Data on pupil characteristics, achievement and classroom verbal behavior of individual pupils were converted to standard scores with a mean of fifty and a standard deviation of ten in order to achieve comparability of scores of the 390 pupils in the sixteen classes observed in this study. The pupil behavior scores were the number of utterances by each pupil as obtained by use of the Verbal Pupil-Behavior Category System. Individuals were placed in "low" or "high" groups, "low" if the standard score was fifty or lower and "high" if the standard score was greater than fifty. The data were cast into two-way contingency tables and a computer program for Chi-square test for two independent samples was used. Several specific null hypotheses were derived from the following general form:
H_o There is no relationship between pupils with characteristic P_c and pupils exhibiting behavior P_b -- where P_c represents characteristics such as Sex, IQ, Mid-Term Average etc. P_b represents various modes and kinds of verbal pupil behavior such as Questioning, Volunteering, Defining, etc.

Parenthetically, correlation coefficients such as Spearman rho, were not calculated since the large number of zero or low pupil behavior scores made the assumption of linearity untenable.

The Chi-squares obtained for the test of independence of selected pupil characteristic variables and selected pupil behavior variables are presented in Table 25. The 5% level of significance was used and a null hypothesis was rejected if a Chi-square equal to or greater than 3.84 (for 1 df) was obtained.

Before proceeding to a discussion of the results in Table 25, the reader is reminded that a number of the pupil characteristics are highly inter-related and the rejection of the null hypothesis of no relationship between P_c and P_b does not necessarily imply the existence of a direct causal relationship between a given characteristic and a particular kind of behavior. In the interest of brevity the results will be discussed primarily in terms of relationships between various pupil characteristics and total pupil-talk, PT. Table 25 may be consulted for more detailed information.

As shown in Table 25 the null hypothesis of no relationship between sex of pupil and class participation was rejected for total pupil-talk (PT) and a number of other categories (Q, V, R, X and XE). Examination of cell frequencies in the contigency tables indicated that a significantly higher proportion of males were high participators.

The null hypothesis of no relationship between (1) the preceding year's average, (2) the current year's mid-term average, (3) the current year's mid-term biology grade and class participation was

TABLE 25 RELATIONSHIPS BETWEEN PUPIL CHARACTERISTICS AND VERBAL PUPIL-BEHAVIORS a/

Pupil Characteristics	Pupil Behaviors											
	Q	S	V	R	D	F	X	E	OT	DF	XE	PT
Sex	7.22+	1.99	10.85+	8.80+	3.47	2.27	16.37+	1.60	1.99	2.55	15.48+	10.97+
IQ	.001	.56	2.73	1.30	5.53*	1.88	1.36	.01	.36	1.55	1.06	1.88
SCAT	1.71	2.29	.48	4.61*	.30	2.67	8.84+	1.27	1.14	5.66*	8.84+	1.55
Final Av. '65	3.21	.31	6.23*	2.97	2.00	17.53+	7.72+	.99	.66	9.22+	7.16+	5.00*
Mid-Term Av.'66	5.01*	.01	8.01+	2.52	5.61*	14.41+	3.66	.004	.00	13.41+	4.06*	5.97*
Mid-Term Bio. Grade '66	17.66+	1.96	15.32+	14.12+	15.39+	23.21+	14.92+	.01	3.64	27.23+	15.61+	17.35+
MSQ	2.25	.01	.95	.13	3.04	3.27	.03	.002	.34	2.84	.005	.08

a/ Figures are Chi-square values

* Significant beyond 5% level

+ Significant beyond 1% level

rejected for PT and a number of other categories. Alternatively, a higher proportion of pupils who were high on these characteristics were high participants. Admittedly, these characteristics are highly inter-related but they were included for reasons such as the following. The previous year's final average and the current year's mid-term average are probably equally good indicators of general ability level of a pupil with the former score having the advantage of being available if a study were to be conducted prior to the mid-term exam. The mid-term biology grade was assumed to be a much more specific index of ability in biology but in choosing it one is faced with the chicken or the egg problem and the writer has arbitrarily given it the status of a quasi-independent variable.

The null hypotheses of no relationship between (1) IQ (2) SCAT (available only for the six classes of teachers 1, 2 and 3) (3) MSQ and class participation were not rejected for PT and most other categories. (For exceptions to this statement see Table 25.)

Inter-Relationships Among Various Categories of Pupil Behavior

Several null hypotheses were derived from the following general form:

H_o There is no relationship between pupils exhibiting behavior P_{bx} and pupils exhibiting behavior P_{by} -- where P_{bx} and P_{by} represent different modes and kinds of verbal pupil behavior.

Chi-squares are presented in Table 26. It can be readily seen that the null hypotheses were rejected in a majority of the cases. Thus, in general the notion that pupils may be categorized into mutually exclusive categories such as low-level or high-level participators was not supported. In other words, a higher proportion of pupils who are high participators on one mode or kind of utterance are also high participators on several other modes or kinds of utterances.

The above statement should not be construed as implying that there were no cases of pupils participating exclusively or predominantly in a particular mode or level of utterances. Inspection of the observation record did indeed reveal pupils with specialised (?) participating styles. Some intriguing research, perhaps using interview techniques, could be done with such pupils. Probably such an approach would greatly further our understanding of pupils' classroom behavior.

TABLE 26 INTER-RELATIONSHIPS AMONG CATEGORIES OF VERBAL PUPIL-BEHAVIOR a/

Pupil Behaviors	Pupil Behaviors										
	S	V	R	D	F	X	E	OT	DF	XE	PT
Q	34.30+	81.17+	17.05+	39.28+	95.83+	86.01+	2.64	45.01+	114.24+	88.42+	134.12+
S		28.71+	12.61+	16.03+	42.91+	40.46+	2.31	22.56+	39.62+	39.54+	47.81+
V			33.33+	73.49+	118.58+	158.84+	18.20+	29.49+	145.88+	156.54+	185.05+
R				44.00+	32.33+	64.14+	3.21	65.66+	52.11+	62.64+	88.61+
D					34.90+	36.18+	1.84	20.48+	132.89+	35.18+	85.46+
F						82.13+	5.81*	20.77+	210.60+	80.43+	160.34+
X							14.97+	21.89+	90.60+	386.68+	200.35+
E								3.42	5.51*	15.83+	21.24+
OT									30.19+	21.10+	68.82+
DF										88.74+	200.92+
XE											197.52+

a/ Figures are Chi-square values

* Significant beyond 5% level

+ Significant beyond 1% level

Relationship Between Pupil Behavior and Pupil Achievement

Several null hypotheses were derived from the following general form:

H_o There is no relationship between pupils exhibiting behavior P_b and pupil achievement P_a -- where P_b represents selected categories of verbal pupil behavior and P_a represents achievement in high school biology as measured by the Final examination (N.Y. Regents in all classes except class numbers 61, 62 and 81) and by the teachers grade in biology for the year.

Chi-squares are presented in Table 27. It can be readily seen that the null hypotheses were rejected in a majority of the cases. Alternatively, a higher proportion of pupils who were high on various types of participation were high on achievement in biology.

The above finding may not be as "obvious" as one may think. The writer has heard teachers voice an opinion contrary to the above mentioned statement.

Certain pupil characteristics, pupil behaviors and pupil achievement are inter-related. Specific research directed to teasing out these complex inter-relationships is needed. The results of the preliminary exploration in this study can provide some guidance for more sophisticated correlational research.

TABLE 27 RELATIONSHIPS BETWEEN PUPIL BEHAVIORS AND PUPIL ACHIEVEMENT a/

Pupil Achievement b/	Pupil Behaviors											
	Q	S	V	R	D	F	X	E	OT	DF	XE	PT
Regents Bio. Grade	8.85+	2.44	16.26+	10.83+	14.73+	24.89+	12.67+	.03	.65	27.01+	11.83+	19.76+
School Bio. Grade	23.36+	6.86+	22.51+	7.56+	12.95+	24.73+	15.58+	.14	1.18	21.20+	14.70+	22.08+

a/ Figures are Chi-square values

+ Significant beyond 1% level

b/ New York State Regents Exams given in June, 1966 in all classes except number 61, 62 and 81 where teacher-made exams were given.

The School Biology grades were given by teachers on the basis of the whole year's work.

CHAPTER IV

CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

A long range program of research on teacher-pupil interaction can be viewed as progressing from the descriptive natural history phase to the correlational phase and finally to the experimental or quasi-experimental phase. The present study is most aptly placed in the natural history stage and is an attempt at instrumentation and description. The major findings reported herein are based on a small number of classes and wide generalizability is not claimed.

A reliable observational technique and a category system consisting of thirty-six mutually exclusive categories were developed for the detailed study of the verbal behavior of each pupil in high school biology lecture-recitation-discussion classes.

The observational technique entailed the use of seating charts and coding each pupil utterance as it occurred. Various two-letter symbols (described below) were used to represent the categories of behavior. Group responses and utterances by unidentifiable speakers were also coded.

The thirty-six categories were formulated by a combination of four modes of pupil-talk and nine kinds of utterances. The four modes were labelled: Questioning (Q), Making Self-Initiated Statements (S), Voluntarily Responding (V), and Replying upon Request (R). The nine kinds of utterances were labelled: Defining (D), Fact-Stating (F), Explaining (X), Evaluating (E), Explicitly referring to the Nature of Science (N), Stating Lack or Limitation of Knowledge (L), Verbalizing Problem-Solving Procedures (P), Dealing with Classroom Routines (R), and Utterances Unclassifiable in the above eight kinds, such as jokes, etc. (U). Each category was symbolized by a two-letter symbol, the first representing the mode and the second the kind of utterance e.g., VF or Volunteering a Fact.

The Verbal Pupil-Behavior Category System (VPBCS) was formulated within the framework of information-seeking and information-giving. The Questioning mode was subsumed under information-seeking and the other three modes were subsumed under information-giving. The various modes were assumed to be indicative of varying degrees of pupil autonomy, independence or initiative.

Almost all of the 3,000 utterances by about 390 pupils in the four periods of observation were in 20 categories. These 20 categories were those formed by the four modes (Q, S, V, R) and five kinds of utterances (D, F, X, E, R). Thus, a somewhat simplified version of the category system would consist of 20 categories formed by pooling the negligibly few utterances labelled N, L, P and U along with R and renaming it Routine and Other (OT).

The category system (VPBCS) was formulated in such a way that the various categories could be combined and recombined in several ways to serve the needs of the observer and thus be used by classroom teachers as well as researchers. Moreover, the VPBCS can be used as a supplement to the Parakh Teacher-Pupil Interaction System as was done in this study and possibly as a supplement to the Flanders and other category systems which primarily classify teacher behavior.

The total number of pupil utterances in the four periods of observation varied greatly in sixteen biology classes. The number of utterances ranged from 73 to 354, with an average of 186 utterances in four class periods or 47 utterances per class period of 40 minutes.

Most of the (verbal) pupil participation in the average class of twenty-four pupils was distributed among a handful of pupils. Typically, four pupils accounted for half of all attributable pupil-talk and eight pupils accounted for three-fourths of the pupil-talk. With few exceptions, these figures were fairly representative of all sixteen classes regardless of size, type of course, ability level, etc.

In the average class, there were five times as many information-giving pupil-utterances as there were questions. The percentages of utterances in the four modes were: Questioning 16%, Self-Initiated Statements 5%, Volunteering 50%, and Replying 29%. From another viewpoint, pupil initiated utterances (Q and S) constituted about one-fifth of all pupil utterances. In short, the modes or ways in which pupils participated or were permitted to participate were largely controlled by the teacher.

In the average class there were approximately equal numbers or proportions of lower-level (DF) and higher-level (XE) pupil-utterances. The relative frequencies of five kinds of utterances were: Defining 13%, Fact-Stating 27%, Explaining 40%, Evaluating 4%, Routine and Other Utterances 15%.

The above conclusions are based on the number of utterances by each pupil, i.e., data obtained by using the Verbal Pupil-Behavior Category System (VPBCS). The conclusions given below are based on the percentage of total class time spent by the teacher and the whole class of pupils in various kinds or categories of behavior, i.e., data obtained by using the writer's Teacher-Pupil Interaction Analysis Category System.

The most conspicuous feature of the observed biology classes was the preponderance of teacher talk. Teacher talk ranged from 68 to 87% of total class time and accounted for 78% of class time in the average class.

The major portion of the average teacher's talk, 57% of class time, consisted of utterances in the Cognitive Dimension. By contrast, the average teacher devoted relatively little time (7%) to social and motivational aspects such as praising, encouraging and accepting student contributions and ideas and devoted about twice as much time (14%) to class management and routine behaviors classified under the Procedural Dimension.

Teacher talk in the Cognitive Dimension consisted almost entirely of giving and seeking substantive information via four quasi-logical operations, namely, defining, fact-stating, explaining and evaluating.

The average teacher used four quasi-logical operations in giving substantive information in the following decreasing order of occurrence: fact-stating 19%, explaining 14%, defining 6%, and evaluating 4%.

The average teacher used four quasi-logical operations in seeking substantive information in the following decreasing order of occurrence: asking for explanations 5%, asking for facts 3%, asking for definitions 2%, and asking for evaluation of subject matter 1%.

Explicit references to the Nature of Science by teachers and pupils were virtually absent, less than 0.1% of the total time in the average class.

Problem-solving behaviors (as represented by categories 7S, 8P, and 15P) occurred infrequently -- about 0.2% of the time in the average class.

Pupil-talk was primarily addressed to the teacher and accounted for 17% of total time in the average class.

Four quasi-logical operations were used by pupils in the average class in seeking substantive information in the following order of occurrence: asking for facts 0.6%, asking for explanations 0.4%, asking for definitions 0.2%, and asking for evaluations 0.1%.

Four quasi-logical operations were used by pupils in the average class in giving substantive information in the following order of occurrence: explaining 5.4%, fact-stating 3.2%, defining 1.9%, and evaluating 1%.

The inter-related giving and seeking of substantive information via four quasi-logical operations by the teacher and pupils was conceptualized as substantive information exchange. In the average class the percent of total time devoted to these exchanges, arranged in decreasing frequency of occurrence were: factual exchanges 26%, explanatory exchanges 25%, definitional exchanges 11%, and evaluative exchanges 6%. Thus, these four kinds of exchanges accounted for about two-thirds of total class time; factual and explanatory exchanges took up approximately equal amounts of class time and accounted for about half of class time.

Silent pauses during interaction occurred essentially between teacher statements and less often between questions and answers and accounted for about 4% of the time in the average class. Thus, time devoted to reflective thinking was relatively scarce.

Behavior sequences were studied and cyclical patterns were found. The most common pattern of classroom behavior of teachers and pupils was observed to occur repeatedly and accounted for 57% of the total interaction. The sequence of behaviors constituting the most common pattern of classroom behavior was: teacher lectured for a few seconds or a few minutes and then asked a question, usually a pupil responded with a brief answer, the teacher usually accepted the pupil's response as satisfactory and resumed lecturing. By using category numbers this pattern was represented as 6 → 8 → 15 → 2 → ... Variations of the above patterns were also found, for example, 6 → 8 → 15 → 6, 6 → 8 → 15 → 8, 6 → 8 → 15 → 3, and 6 → 8 → 15 → 11.

A detailed study of interaction patterns revealed that the average teacher structured and directed the classroom discourse within well prescribed channels, i.e., within specific quasi-logical operations. Teacher behavior within a specific quasi-logical operation was most frequently followed by further teacher behavior or by pupil behavior in the same quasi-logical operation. Thus, much (but not all) of the classroom discourse could be described as occurring in more or less distinct packets or exchanges of the four quasi-logical operations.

There were wide differences in interaction scores among classes of different teachers for the majority of the categories and great similarity in scores on a number of categories. These differences and similarities did not appear to be distinctly related to ability level of the classes and suggested that high school biology teaching probably approximated a general descriptive model or common pattern with a variety of individual variations.

Interaction scores in two classes taught by the same teacher were found to be generally similar. While a number of differences were found, these did not appear to be systematically related to ability level of the class. However, some differences were suggestive and further research is needed.

A preliminary search was made for relationships among and between four classes of variables: teacher behaviors, pupil behaviors, pupil characteristics and pupil achievement.

Teacher's lecturing or information-giving was positively related to pupil questions but negatively related to pupils' responses, while teachers' questioning was positively related to pupil responses but negatively related to pupil questions. These findings did not support the notion that the pupils patterned or modelled their questioning according to the questioning style of the teacher. The above statements of relationship are based on values of Spearman correlation coefficients (rhos) significantly different from zero beyond the 5% level and calculated from interaction scores obtained from the teacher-pupil interaction analysis system. The following statements of relationship are based on Chi-square tests of independence.

Pupil characteristics such as intelligence (as measured by Lorge Thorndike and California Test of Mental Maturity), school and college aptitude (SCAT) and attitudes towards teacher, subject and class (as measured by Michigan Student Questionnaire) were generally not significantly related to pupil talk and certain categories of pupil talk.

Pupil characteristics such as sex and ability (as measured by the preceding year's average grade, the current year's mid-term average grade, the mid-term biology grade) were significantly related to pupil talk and certain categories of pupil talk. A higher proportion of boys were high participants and a higher proportion of high ability pupils were high participants.

The various categories of pupil behavior were significantly related. A higher proportion of pupils who were high participators on one mode or kind of utterance were also high participators on several other modes or kinds of utterances.

Classroom behavior of pupils was significantly related to achievement (as measured by the New York Regents Examination and the teacher's final grade in biology). A higher proportion of pupils who were "high" in various categories of participation were also high on achievement in biology.

Specific research directed to teasing out the complex interrelationships among the above mentioned four classes of variables is needed to further our understanding of the teaching-learning processes in classrooms.

The results of this study have a number of implications for further research and teacher training.

Objective, detailed, quantitative description of the verbal behavior of each pupil in lecture-recitation-discussion classes in biology and probably other subjects can now be obtained by a systematic observational technique and category system such as the one developed in this study. Research into the nature of pupil participation at various grade levels and in various subjects could provide needed information about how pupils behave and learn in a variety of situations. Such studies could be coupled with studies of how selected pupils, say high and low participators in one class, behave in other classes and some of the factors related to their participation.

Striking discrepancies have been noted between observed classroom behavior and classroom behavior recommended in methods courses, books, articles and speeches especially with reference to teaching the Nature of Science, teaching science as inquiry etc. It should also be recalled that most of the teachers observed in this study had been participants in various in-service institutes supported by the NSF and other agencies. It has often been claimed that these institutes not only "up-date" the teacher's content background but also train teachers to teach science as inquiry. More than exhortations and speeches are needed. Teacher-training programs must be developed to specifically train teachers in the techniques of teaching science as inquiry.

Discrepancies also existed between what teachers said and thought they were doing and what was objectively observed. For instance the teachers observed in this study stated that they used the "discussion method" more often than the "lecture method" and that they "don't do much lecturing". The data obtained in this study indicate that except for a few classes there was relatively little discussion, searching and questioning by students. Objective and non-evaluative feedback needs to be provided to teachers so that they can bring about a closer correspondence between their intentions and practices. Such feedback can be readily provided by using category systems and observational techniques such as the ones developed by the writer and other researchers.

There are some interesting implications of the finding that a handful of pupils accounted for most of the pupil talk in all sixteen classes regardless of heterogenous or homogenous grouping, ability level, sex distribution, type of course, etc. -- the reader may recall that about eight pupils accounted for about three-fourths of the pupil talk. If it is assumed or if it can be empirically established that more widespread and active pupil-participation is necessary for better achievement of carefully specified objectives then teacher training programs need to be developed such that teachers can get the necessary practice and skill in encouraging more widespread and active participation -- a task which appears to be quite difficult, especially when the average teacher talks about 78% of the time. If on the other hand, as workers in group dynamics suggest, a group of eight is close to the maximum size for effective and genuine discussion and discussion methods of teaching are to be used (rather than merely claimed) then serious thought needs to be given to ways of breaking up the usual class of twenty-four or more students in smaller groups for active discussion. Of course this also entails changes in administrative arrangements and most importantly calls for a rather marked change in the "rules of the classroom game" as currently played. Research entailing planned and systematic changes in the "rules of the classroom game" may be premature with the present state of our knowledge but hopefully it will not be too far off.

There is another important implication of the finding that a handful of pupils account for most of the teacher-pupil interaction. Following the work of a number of researchers (5, 6, 10, 15, 23, 45, 46 and others) it has been generally accepted that teacher' behavior -- the kinds of things teachers say and do -- have a profound influence on the "climate" of the classroom and on pupil outcomes such as attitudes and achievement. If not stated as such, it has been implicitly assumed that the teachers influence the whole class of pupils or most of the pupils more or less equally. The wide range in pupil outcomes within classes are generally blurred by comparing mean achievement scores and the wide range in pupil behaviors is not taken into account by attributing any and all utterances by individual pupils to the whole class. The extant model of teacher-pupil interaction with the teacher on one side of the desk interacting with and supposedly influencing the "averaged out" class of pupils on the other side of the desk needs to be revised. In all fairness, this model has enabled researchers to come to grips with at least a few of the subtleties and complexities of classroom life. However, with the advances in observational techniques, the increasing availability of audio and video tape-recorders and the possibilities opened by computers it should be possible to conduct studies that can furnish empirical grist for the conceptual mill. A revision of the extant model is beyond the scope of this study and would be premature in the absence of more information about how in their interaction teachers take or can take into account factors such as sex, ability level, personality traits, etc. of the pupils.

The prodigious efforts of recent years to improve science teaching have taken the all too familar forms of providing more up to date texts and materials and in improving the subject matter competence of teachers. Comparatively little attention has been given to the variety of ways in which these up to date materials can be handled to achieve the desired objectives. It is imperative in both the pre-service and in-service training of teachers of science that student-teachers and teachers acquire skills of systematic observation and analysis of the complex processes of teaching and that they have an opportunity to practice and develop instead of merely reading and hearing about the skills of teaching science as inquiry!

CHAPTER V

SUMMARY

Within the last ten years, systematic quantitative observation and analysis of teacher-pupil interaction has become an active and significant area of educational research. Numerous category systems have been developed since the publication of the well know Flanders system in the late nineteen-fifties. In most of these category systems, including one developed by the author in a previous study, the major emphasis has been placed on categorization of teacher behavior. The utterances of all participating pupils are lumped together in a few categories. Investigators generally report that pupil talk usually accounts for about 20 to 30% of the time spent in classroom discourse --but it is not known whether all the pupils or only a small number of the pupils participated. Implicitly or explicitly, the assumption is made that the teacher's behavior influences the pupils as a group and attempts are made to relate teacher behavior scores to class mean scores on achievement and attitude tests.

Despite our prouncements about the individuality and uniqueness of each learner, systematic quantitative descriptions of individual pupils engaged in classroom activity are particularly limited. A striking gap also exists in our knowledge of the complex relationships among teacher behaviors, pupil behaviors, pupil characteristics and pupil achievement.

The major objectives of this study were:

1. To develop a reliable systematic observational technique and a category system for on-the-spot classification of the verbal behavior of each pupil in high school biology lecture-recitation-discussion classes.
2. To quantitatively describe and analyze the observed behavior of individual pupils, sub-groups of pupils and the classroom group as a whole.
3. To classify and describe the teacher-pupil interaction in homogenously and heterogenously grouped biology classes.
4. To conduct a preliminary exploration of the network of relationships a) between various categories of teacher behavior and various categories of pupil behavior b) between pupil characteristics and pupil behavior c) among various categories of pupil behavior and d) between pupil behavior and pupil achievement.

Two classes each of eight high school biology teachers from three schools in Central New York were observed for four consecutive days in the Spring of 1966, i.e., a total of 64 (or 2x8x4) lecture-discussion periods. Teachers 1 to 5 used the BSCS Yellow Version. Teacher 6 used the BSCS Green Version and Teachers 7 and 8 used non-BSCS materials. During each observational visit the classroom discourse for the entire period was recorded on audio-tape. Simultaneously, the live verbal behavior of each pupil was categorized into one of 36 mutually exclusive categories (developed in this study) and coded in the appropriate block of a seating chart. The 36 categories were derived by using four modes of pupil participation, viz., Questions (Q), Self-Initiated Statements (S), Volunteering Information (V), Replying to Teacher Requests, and combining with nine kinds of utterances, viz., Defining (D), Fact-stating (F), Explaining (X), Evaluating (E), Explicitly referring to Nature of Science (N), Indicating Lack of Knowledge (L), Suggesting Problem-solving Procedures (P), Dealing with Classroom Routines (R), and a category for utterances Unclassifiable in above eight kinds (U).

Each category was designated by a combination of two letters of the alphabet -- the first letter designating one of the four modes and second letter one of the nine kinds of utterances. In addition the sequence of utterances was also preserved by means of numerical subscripts. For example, the code QD_{50} in a particular seating block would indicate that that pupil had asked a question regarding a definition and moreover that this was the fiftieth pupil utterance during that class period.

The pupil behavior data were transferred from seating charts to punched cards and were processed to yield a) the number and percentage of utterances in each of the categories and various groups of categories and b) the number and percentage of pupils who participated in various categories.

Data on pupil characteristics such as sex, intelligence, ability and pupil achievement were obtained from records of pupils made available by the cooperating schools. Owing to the different tests of intelligence, ability, etc. used by the different schools these scores were converted to standard scores. Pupil behavior scores were also converted to standard scores and Chi-square tests of independence were used to test several null hypotheses of no relationship between and among pupil characteristics, pupil behaviors and pupil achievement.

The complete tape-recorded teacher-pupil interaction was subsequently categorized according to a 45-category system (developed by the writer in a previous study). Briefly, the following procedure was used. Keeping as steady a tempo as possible, the coder wrote down one category number every five seconds to represent the discourse in that five second interval. If shifts or changes in the category of behavior occurred more rapidly then those shifts were also coded. At the end of each class period of about 40 minutes the observational record consisted of about 500 category numbers written in the sequence in which the classroom verbal behavior had occurred. For example, ...6F, 6F, 6F, 8D, 8D, 15D, 3,.... represents a sequence wherein the teacher states facts (15 seconds), then asks for a definition (10 seconds), a pupil gives a definition (5 seconds), the teacher corrects the definition (5 seconds).

The data were processed to yield a number of interaction matrices and interaction scores for each class. Since the interaction was coded in time units (five-second intervals), rather than the number of the various kinds of behaviors, the results are expressed as percent of total time based on four-lecture periods per class. In the case of the "average" or more accurately composite teacher and class the percentages are based on 2 x 4 x 8 or 64 lecture-discussion classes.

Selected interaction scores of teachers and the whole class of pupils were used to test several null hypotheses of relationship between teacher behaviors and (aggregate) pupil behaviors. Spearman correlation coefficients were calculated.

The major findings are summarized below:

A category system consisting of 36 categories (described earlier) was developed for the classification of the verbal behavior of each pupil in high school biology lecture-discussion classes. Utterances of pupils were coded on seating charts. Inter-observer reliability calculated as simple percentage agreement between the investigator and an observer trained by the investigator and based on total participation scores for each pupil for four periods of observation were encouragingly high -- typically about 80% agreement.

Inspection of the data revealed that pupil utterances within the four modes dealt primarily with Definitions, Facts, Explanations, (relatively few) Evaluations, and Routines. There were virtually no utterances in the categories designated Nature of Science, Suggests Problem Solving Procedures, Indicates Lack of Knowledge and Unclassifiable. Consequently, these negligibly small tallies were added to the category Routine and renamed Other (OT).

In the average classroom of 24 students there were 186 utterances in the four periods of observation. a) Arranged in decreasing order of occurrence, the relative frequencies of the four modes of participation were: Volunteering 50%, Replying to Teacher's Request 29%, Questioning 15%, and Self-Initiated Statements 5%. b) Arranged in decreasing order of occurrence, the frequencies of five kinds of utterances were: Explanations 40%, Facts 27%, Definitions 13%, "Other" (primarily class Routine) 15%, and Evaluations 4%.

In the average classroom two pupils accounted for about 25% of the pupil talk, four pupils accounted for about 50% of the pupil talk and eight pupils accounted for about 75% of the pupil talk. Interestingly, these figures were fairly representative of all 16 classes observed regardless of the difference in the number of pupils in the classes which ranged from 15 to 37 pupils per class, the ability levels of the classes, etc.

The above results are based on the number of utterances by each pupil, i.e., data obtained by using the Verbal Pupil-Behavior Category System. The results given below are based on the time spent by the teacher and the whole class of pupils in various kinds or categories of behavior, i.e., data obtained by using the Parakh Teacher Pupil Interaction Analysis Category System.

The most conspicuous feature of the observed biology classes was the preponderance of teacher talk. Teacher talk ranged from 68 to 89% of total class time and accounted for 78% of class time in the average class.

The major portion of the average teacher's talk, 57% of class time, consisted of utterances in the Cognitive Dimension. By contrast, the average teacher devoted relatively little time (7%) to social and motivational aspects such as praising, encouraging and accepting student contributions and ideas and devoted about twice as much time (14%) to class management and routine behaviors classified under the Procedural Dimension.

Teacher-talk in the Cognitive Dimension consisted almost entirely of giving and seeking substantive information via four quasi-logical operations, namely, defining, fact-stating, explaining and evaluating.

The inter-related giving and seeking of substantive information via four quasi-logical operations by the teacher and pupils was conceptualized as substantive information exchange. In the average class the percent of total time devoted to these exchanges, arranged in decreasing frequency of occurrence were: factual exchanges 26%, explanatory exchanges 25%, definitional exchanges 11%, and evaluative exchanges 6%. Thus, these four kinds of exchanges accounted for about two-thirds of total class time; factual and explanatory exchanges took up approximately equal amounts of class time and accounted for about half of class time.

Explicit references to the Nature of Science by teachers and pupils were virtually absent, less than 0.1% of the total time in the average class.

Problem-solving behaviors (as represented by categories 7S, 8P, and 15P) occurred infrequently -- about 0.2% of the time in the average class.

Pupil-talk was primarily addressed to the teacher and accounted for 17% of total time in the average class -- 2.7% of the time for questions and 14.3% of the time for responses.

Silent pauses during interaction occurred essentially between teacher statements and less often between questions and answers and accounted for about 4% of the time in the average class. Thus, time devoted to reflective thinking was relatively scarce.

Behavior sequences were studied and cyclical patterns were found. The most common pattern of classroom behavior of teachers and pupils was observed to occur repeatedly and accounted for 57% of the total interaction. The sequence of behaviors constituting the most common pattern of classroom behavior was: teacher lectured for a few seconds or a few minutes and then asked a question, usually a pupil responded with a brief answer, the teacher usually accepted the pupil's response as satisfactory and resumed lecturing. By using category numbers this pattern was represented as 6→8→15→2→... Variations of the above patterns were also found, for example, 6→8→15→6, 6→8→15→8, 6→8→15→3, and 6→8→15→11.

A detailed study of interaction patterns revealed that the average teacher structured and directed the classroom discourse within well prescribed channels, i.e., within specific quasi-logical operations. Teacher behavior within a specific quasi-logical operation was most frequently followed by further teacher behavior or by pupil behavior in the same quasi-logical operation. Thus, much (but not all) of the classroom discourse could be described as occurring in more or less distinct packets or exchanges of the four quasi-logical operations.

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Interaction scores in two classes taught by the same teacher appeared to be generally similar. While a number of differences were found, these did not appear to be systematically related to ability level of the class. However, some differences were suggestive and further research is needed.

A preliminary search was made for relationships among and between four classes of variables: teacher behaviors, pupil behaviors, pupil characteristics and pupil achievement.

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Pupil characteristics such as sex and ability (as measured by the preceding year's average grade, the current year's mid-term average grade, the mid-term biology grade) were significantly related to pupil talk and certain categories of pupil talk. A higher proportion of boys were high participants and a higher proportion of high ability pupils were high participants.

The various categories of pupil behavior were significantly related. A higher proportion of pupils who were high participators on one mode or kind of utterance were also high participators on several other modes or kinds of utterances.

Classroom behavior of pupils was significantly related to achievement (as measured by the New York Regents Examination and the teacher's final grade in biology). A higher proportion of pupils who were "high" in various categories of participation were also high on achievement in biology.

Specific research directed to teasing out the complex interrelationships among the above mentioned four classes of variables is needed to further our understanding of the teaching-learning processes in classrooms.

Category systems such as the ones developed by the writer in this study and an earlier one can be used to give teachers objective feedback. The wide discrepancies observed between recommended practices and observed practice and also between what teachers think they do or intend to do and observed practice make it imperative that teacher training programs be developed so that student-teachers and experienced teachers can acquire skills of systematic observation and analysis of their teaching. It is also imperative that teachers of science be provided with opportunities to practice and develop instead of merely reading and hearing about the skills of teaching science as inquiry.

Further research is needed to determine the nature of individual pupil participation and teacher-pupil interaction at various grade levels and in various science classes (and other classes).

The extant model of teacher-pupil interaction with the teacher on one side of the desk interacting with and supposedly influencing the "averaged out" class of pupils on the other side of the desk needs to be revised.

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APPENDIX A

A CATEGORY SYSTEM FOR THE CLASSIFICATION OF TEACHER-PUPIL INTERACTION IN BIOLOGY CLASSES

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A CATEGORY SYSTEM FOR THE CLASSIFICATION OF TEACHER-PUPIL INTERACTION IN BIOLOGY CLASSES

Description of the Category System

The category system has sixteen major categories, designated by numbers one to sixteen, and twenty-eight sub-categories, designated by a combination of a number and a letter. The term category, when used without the modifier, refers to both the major categories and the sub-categories. The present category system has thirteen major categories for classifying teacher behavior, two major categories for classifying pupil talk, one for silence or pauses in communication and a residual category, Category 17, for interaction uncodable in any of the above categories. While reading this section the reader is strongly urged to refer to the outline of the category system given in the next section.

The thirteen categories of teacher-behavior are grouped into three major dimensions, namely, Evaluative, Cognitive and Procedural dimensions. The major dimensions are composed of sub-dimensions, such as "Information-Giving" and "Information-Seeking." The sub-dimensions are in turn composed of major categories, and certain major categories are sub-divided into sub-categories.

Evaluative Dimension (Affective-Substantive)

The dominant feature of the Evaluative Dimension is the effect of the teacher's behavior on the affective or social-emotional climate of the classroom. However, this is a mixed dimension, since all statements made by the teacher and having the effect of evaluating either the pupil's social conduct or his cognitive-task-behavior are classified into one of the four major categories in the Evaluative Dimension. Category one, teacher praises; and category four, teacher reprimands; constitute the "positive" and "negative" ends of a continuum. These categories are most closely related to the affective climate of the classroom. Category two, teacher accepts pupil's substantive contributions; and category three, teacher corrects pupil's substantive contributions; constitute the "neutral" or task related area between the two ends of the continuum.

The effects of the above-mentioned evaluative statements are highly inter-related, but for analytical purposes these statements are classified separately. No scale values are implied for the various categories.

Cognitive Dimension

By far the greatest amount of classroom activity and time is devoted to the achievement of objectives in what is generally called the "Cognitive Domain," and most of the categories in this system are devoted to the classification of the cognitive or intellectual behavior of teachers and pupils. As Gage (17) states: "Cognitive structure refers to the organization of facts, concepts and principles. Such a structure is not arbitrary. It is determined partly by how man's mind works and partly by the nature of the subject, i.e., the "intellectual discipline" to be learned. The cognitive structure of logical processes exerts force; it compels assent to a conclusion..."

Two sub-dimensions of the Cognitive Dimension are "Substantive Information-Giving" and "Substantive Information-Seeking." Substantive information, or in this case, the subject matter of Biology, is composed of both "product" and "process." The "product" refers to the facts, concepts, principles, theories, etc. of Biology, while the "process" refers to the scientific processes and methods that generate the "product." Here again process and product are inter-related, but are separated for analytical purposes.

Cognitive or substantive information is primarily communicated or exchanged verbally by logical or quasi-logical processes in most of the traditional school subjects. However, in science, demonstration of phenomena, manipulation of apparatus (category five) and visual observation aided or unaided by instruments (category nine) constitute important non-verbal modes of giving and seeking information. Accordingly, the substantive information-giving and information-seeking behavior is further classified into verbal and non-verbal behavior. The verbal discourse in the cognitive domain is still further classified according to the criterion of logicality, as "logical" e.g., categories 6D, 6F, 6X, 6E and "extra-logical," e.g., categories 7,7C, 7S. However, according to modern linguistic conceptions of language, what a person does with language and how he uses it over-rides strictly formal and logical properties, as Hockett has cogently stated: "From the linguistic point of view, the "logical" approach to language is too narrow." Hence, in the present category system Defining, Fact stating, Explaining and Evaluating are viewed as quasi-logical operations rather than formal or "ideal" logical operations, as viewed by Smith et. al. (37) and Bellack and Davitz (8). In brief, the criterion can be illustrated as follows: if the effect of the speaker's words is to give the meaning of a term, then the utterance is categorized as giving a definition even though on formal-logical criteria the speaker did not give a complete definition. Similarly, the "rules" for the other quasi-logical operations are given under the appropriate categories in an ensuing section entitled "Definitions of Categories."

Procedural Dimension

This dimension subsumes all the behavior variously described as class routines, classroom mechanics, class procedures, classroom management etc. Such behavior is first grouped into two sub-dimensions namely verbal and non-verbal procedural behavior. The verbal procedural behavior is further subdivided according to the criteria of information-seeking (category ten) and information-giving (category eleven). The non-verbal procedural behavior is subdivided according to whether the teacher is engaged in the performance of routines and "service" (category twelve), or whether the teacher is engaged in minimal interaction (category thirteen).

In most category systems scant attention is given to the procedural or routine dimension. However, this dimension accounts for a considerable proportion of the time spent by the teacher, especially in laboratory classes. It is reasonable to expect that the ways in which classroom routines and procedures are managed or handled can have a sizeable effect on the affective and cognitive climate of the classroom.

Pupil-Talk Dimension

Much of the pupils' verbal behavior in a classroom is isomorphic to the teacher's verbal behavior, especially in the Cognitive Dimension, and hence such pupil behavior could be easily classified into a set of categories similar to those used for classifying teacher behavior. However, the pupils' behavior (at least, that observed during the category development phase of this study) differed notably from the teacher-behavior in the following respects: (1) Pupils seldom, if ever, overtly evaluated the teacher's behavior in the classroom--i.e., few or no parallels to categories one, two, three and four. (2) Pupils seldom gave demonstrations, laboratory directions, procedural directives, and seldom examined, corrected, or supervised the work of other pupils--i.e., few or no parallels to categories five, seven, nine, eleven, twelve and thirteen. In view of the above exceptions, and since the emphasis in this study is primarily on teacher behavior, the writer decided to allot the smallest number of categories to pupils' verbal behavior, without significant loss of detail and information. Hence, only one "dimension", consisting of two major categories, is used to classify the verbal behavior or pupils. Admittedly, "Pupil-Talk" is a mixed dimension since the "Substantive" information giving and seeking as well as "Procedural" information giving and seeking behaviors are included in a single dimension. The reader will note that the pupils' substantive information-giving are subdivided according to the same criteria of "logical" and "extra-logical" operations used earlier in the classification of teacher's behavior. By using this procedure the "memory-load" and the numbers and kinds of discriminations is kept to a minimum. In effect, fourteen sub-categories of the pupils' verbal behavior are classified under two major categories.

Silence

This category is used only for short pauses in communication during teacher-pupil interaction and is not used for classifying non-verbal behavior specified in other categories.

Not Categorizeable in the Category System

The presence of this "residual category" is important in determining the exhaustiveness of the system, especially, during the development of a category system. Such a category may become less important, or at least have decreasing use, after the initial trials and revisions of a category system. This category is used for behaviors that cannot be classified or categorized into any of the other categories in the system.

OUTLINE OF CATEGORY SYSTEM FOR INTERACTION ANALYSIS IN BIOLOGY CLASSES

EVALUATIVE DIMENSION (AFFECTIVE - SUBSTANTIVE)

"Positive" Affective Evaluation

1 T Praises, Encourages, Jokes, Reduces Tension, Accepts Feelings

Evaluation of Substantive Responses

2 T Accepts Pupil's Substantive Responses or Work, and Contributions

3 T Qualifies, Corrects Pupil's substantive Responses, Work, and Contributions

"Negative" Affective Evaluation

4 T Reprimands Pupil for Misbehavior, Uses Sarcasm, Shouts, Threatens

COGNITIVE DIMENSION (GIVING OR SEEKING SUBSTANTIVE INFORMATION)

Substantive Information Giving

Non-Verbal

5 T Gives Demonstration of Technique, Process, Phenomenon, etc.

Verbal

6 T Gives Substantive Information

6D T Defines Terms, Gives Examples of Terms

6F T States Facts, Describes, Gives an Account or Report of an Event

6X T Explains, Makes Inferences, Makes Comparisons, States Relationships between Objects, Events, Generalizations

6E T Evaluates, Makes Value Judgment, Gives Opinions about the Subject Matter

6N T Gives Information about the Nature of Science

6L T Makes Statements about Lack of Information and Limitation of Knowledge

7 T Gives Laboratory and Substantive Directions

7C T States Precautions or Requires Strict Adherence to Certain Steps in the Procedure to be Followed

7S T Suggests or Allows Alternative or New Approaches to an Experiment, Activity or Problem

Substantive Information Seeking

Verbal

8 T Asks Questions

8D T Asks Pupil to Define Terms, Give Examples of Terms

8F T Asks Pupil to State Facts, Describe, Give an Account or Report of an Event

8X T Asks Pupil to Explain, Make Inferences, Make Comparisons, State Relationships between Objects, Events, Generalizations

8E T Asks Pupil to Evaluate, Make Value Judgment, Give Opinions about the Subject Matter

8N T Asks Pupil to Give Information about the Nature of Science

8P T Asks about Problem Solving Procedures, Techniques, Steps to be taken to carry out experiment, or to solve a problem that grows out of, or is an extension of the "required" work

Non-Verbal

9 T Examines, Checks, Looks at, Pupil's Work

PROCEDURAL DIMENSION

Verbal

Seeking Procedural Information

10 T Asks Questions regarding Class Routines, Assignments, Procedures, Materials, T Asks if Pupils Understand, Need Help, Clarification, Repetition

Giving Procedural Information

11 T Gives Routine Directives, Gives Assignments, Gives Procedural Orientation, Explicates Transition of Topics

Non-Verbal

Performance of Routines and Services

12 T Attends to Routines and Class-Management, Distributes Materials, Prepares Materials, Performs Services, Takes Attendance, Marks Papers, Consults Notes and References

Minimal Interaction

13 T Oversees or Supervises Pupils at Work, Walks around, Stands or Sits at his desk or some other part of the room and watches pupils doing seat work or laboratory work

PUPIL TALK DIMENSION (GIVING OR SEEKING INFORMATION)

14 P Asks for Substantive Information and Assistance

Substantive Information Seeking

14D; 14F; 14X; 14E; 14N (See Category 8.)

Procedural Information Seeking

14A P Seeks Assistance, Asks About Directions, Procedures, Techniques, Materials, Routines

15 P Gives Information or Responds

Substantive Information Giving

15D; 15F; 15X; 15E; 15N; 15L (See Category 6.)

15P P States, Describes, Explains, Proposes the steps he will or would take in order to solve the problem or carry out an experiment that grows out of or is an extension of the "required" work

Procedural Information Giving

15R P Gives Information Regarding Assignments, Classroom Procedures and Routines

SILENCE

16 Short Silent Periods especially after questions by teacher or pupil, or after directives that are to be complied with immediately. Also included are silent pauses four seconds or longer in the middle of a sentence or between sentences. Shift to the appropriate category, 9, 12 or 13, when pupils are engaged in seat work or laboratory work or for periods of silence longer than 30 seconds.

NOT CATEGORIZABLE

17 Not Categorizable in Above System. The observed behavior cannot be classified into any of the above categories.

Procedure for Categorizing Teacher-Pupil Interaction

1. The observer should be seated and ready to start coding or categorizing before the class begins. By prior arrangement with the teacher the observer should select a seat in the back or at the side of the room such that the observer is as unobtrusive as possible while still in a position to clearly see and hear the classroom interaction.

2. The observer starts categorizing as soon as the bell or buzzer sounds or the teacher starts the class, whichever comes first, and continues categorizing until the teacher dismisses or excuses the class, or the class leaves at the sound of the bell or buzzer.

3. Keeping as steady a tempo as possible, every five seconds the observer writes down one and only one category number to classify the interaction just observed in the preceding five seconds. The category numbers are recorded in sequence in rows. If a "shift" or change in interaction category occurs in less than five seconds the observer records all such shifts, for instance, teacher question--student response--teacher evaluation of response, may occur in rapid succession. If no "shift" or change occurs repeat that category number at the end of the next five seconds.

4. The observer writes 16, the category number for "silence", at the beginning and end of each period of observation so that the row and column totals in the matrix will be the same. Sixteen is selected somewhat arbitrarily.

5. The observer does not categorize the following kinds of behavior:
    a) Pupil raises hand requesting permission to ask a question or give an answer.
    b) Pupil calls the teacher's name in order to ask a question or give an answer.
    c) Teacher nods, points to, or calls a pupil by name or otherwise indicates permission to speak in response to pupil's upraised hand or call.
    d) Interruption of "regular" class work is noted in the margins, e.g., announcements over the public address system, telephone calls, messengers or other visitors talking to the teacher, special announcements read or made by teacher which are clearly not a part of the regular classroom routines and procedures. The observer writes the time elapsed or puts a dot every five seconds to account for the time elapsed, e.g., [P.A. announcement 23 secs.] or [Telephone .....]. At the end of the "interruption" the observer resumes categorization.
    e) Teacher mumbles or talks to himself, e.g., while looking for supplies, looking through his notes, or while examining a pupil's work.

6. The observer writes brief notes in the margin, describing the kind of class activity or matters of interest to the observer.

7. The observer categorizes from the perspective of the "generalized other." Only the observed classroom communication is categorized according to the effect it has on the observer as he takes the role of the "generalized other." The observer should constantly be on guard against categorizing on the basis of his own biases or inferences regarding the teacher's or pupil's intentions and deep seated psychological motivations. To repeat--only the overt and observable behaviors are categorized.

Definitions of Categories

Category 1. Teacher Praises, Encourages, Jokes, Reduces Tension, Accepts Feelings. The teacher praises, rewards, acknowledges the contributions and efforts of the pupils. The tone of voice usually conveys pleasure, satisfaction, or positive evaluation. Often a single word or phrase is used with accentuation rather than a matter of fact tone of voice, e.g., right; good; exactly; that is a good slide. The teacher encourages the student to continue or pursue an idea further, e.g., go on; what else; ...yes...yes...; and; anymore; uh, huh; I think you've almost finished the dissection, keep going. This category also includes jokes, humor that is not at the expense of pupils, and statements that help to reduce tension or anxiety. The teacher accepts and understands the pupil's feelings of confusion, frustration, anger, boredom, joy, satisfaction, pleasure, e.g., I know this is pretty hard to understand at first; you look puzzled, let's go over this again; I think I know how you feel; that's pretty interesting, isn't it? Also included in this category are questions or comments expressing interest or concern in the pupil's personal health or progress in school: Is your shoulder ok now? How are you doing in your other subjects?

Category 2. Teacher Accepts Pupil's Ideas, Contributions, Work. The teacher repeats a pupil's answer in part, in summary or in full, with or without minor rephrasing. The teacher states in a neutral or matter of fact tone of voice that the response is correct, or that the pupil's ideas or suggestions are useful or worth taking into account, e.g., that's an interesting idea; that's another point; that slide is ok; yes; correct; right. (The teacher does not qualify, or correct the pupil's response. The observer must be alert to quick shifts from category two to category one or three).

Category 3. Teacher Modifies, Qualifies or Corrects Pupil's Substantive Responses, Contributions or Work. This category is restricted to substantive or subject matter related statements, responses, and contributions made by the pupils. Reprimanding, scolding, correcting misbehavior are not included in this category but rather in category four. The tone of voice is usually business-like or matter of fact. The teacher's statements ranging from slight qualification to complete rejection or correction are included, e.g., almost, but not quite...; that's generally true, but not in this case...; no, that's an artery, not a vein. Sometimes the teacher "corrects" the pupil's response by asking a question; Is that a genotype? Is that a hormone? Are you sure you used 5cc of Fehling's solution?

Category 4. Teacher Reprimands Pupil(s) for Misbehavior, Uses Sarcasm, Shouts, Threatens, Complains. Teacher corrects pupil's misbehavior, scolds, shouts, uses sarcasm, tells student to change his seat, to leave the classroom, deflates pupil's status, expresses displeasure at students' behavior. Teacher justifies or defends his authority, e.g., Bill! just once more and I'll send you out; that's a bright thing to do; sit down; stop talking; I don't know how I'm going to get any work out of you; I told you not to fool around with the bunsen burner; Why don't you pay attention?

Category 5. Teacher Gives Demonstration of Techniques, Process, Phenomenon, etc. Teacher shows (by actual manipulation) how apparatus is to be set up, or used. Teacher actually carries out some laboratory activity, such as using the microscope or dissection, using chemicals, anesthetizing a frog, etc. Teacher may "demonstrate" (or show how) at pupil's laboratory desk or in front of whole class silently or along with questions, directions, explanations, etc. Categorize both the non-verbal and verbal, e.g., you take an eye dropper and add the reagent drop by drop by drop like so and...; you hold the test-tube pointed away from you, like this, and...; watch carefully as I add this; why did it burn? The use of visual aids such as diagrams, charts, slides, models, etc. are not included in this category.

Category 6. Teacher Gives Substantive Information. The teacher defines terms, gives names of objects, states facts, laws, theories, describes objects, processes, gives explanations, reasons, relationships, engages in inductive or deductive reasoning, makes value judgments, gives opinions, gives information about the nature of science, states that he or scientists lack certain knowledge. Note: The word "object" is used to include non-living things as well as organisms or parts of organisms, and the word "information" is used rather broadly to include definitions, facts, explanations etc. Where applicable the following sub-divisions or sub-categories are used, viz., 6D, 6F, 6X, 6E, 6N, 6L. The designation 6U is used to indicate that the "information" cannot be classified or categorized in one of the sub-categories of "6."

Sub-Category 6D. Teacher Defines Terms, Gives Examples of Terms. Teachers convey meanings of terms in many ways, such as the following:
1) By giving examples of terms, e.g., legumes are plants like clover, peas, alfalfa, and so on; the heart, the stomach, the lungs, the liver, and so on -- these are all examples of organs; another kind (type or example) of asexual reproduction is budding.
2) By pointing to the object, model, diagram, picture, etc., e.g., this is a burette; this is the eye piece; here's the anther.
3) By using symbols, synonyms, expressions having similar meaning, e.g., carbon is C; sucrose or cane sugar; DNA or deoxyribonucleic acid.
4) By giving the genus or class term and differentia (classificatory definition) e.g., an artery is a blood vessel that carries blood away from the heart. The genus or class term is "blood vessel" and "carries blood away from the heart" is the differentia. The differentia may be functions, processes, qualities or properties or attributes, e.g., the ventricles are the thickest chambers of the heart; the ventricles are the pumping chambers of the heart; the biceps are the muscles that bend the arm. Note: The distinction between a classificatory definition and description of an organism or object is often subtle and difficult to make since teachers may actually make a short descriptive statement as a way of "defining" or add a descriptive statement to the differentia. Contextual clues need to be used in deciding which category to use. Strictly speaking, to define is to give only the defining or essential characteristics. A word is said to be defined completely when all the essential

characteristics are stated, however, teachers may give incomplete definitions or give a few of the defining characteristics at a time. Also, teachers may give associated as well as common or shared characteristics to convey the meaning of the term, e.g., vitamins are chemicals that are needed by the body to maintain good health. (So are many other chemicals.)

Hence, in deciding whether to use Category 6D or 6F, the observer should judge on the basis of contextual clues whether or not the teacher is trying to develop the vocabulary and terminology or is giving factual or descriptive information. When in doubt between 6D and 6F, use 6D on the assumption that this is the "meaning" the pupil is given, at least for the time being.

Sub-Category 6F. Teacher States Facts, Describes, Gives an Account or Report of an Event. Teacher states facts without explaining or giving relationships between facts, gives an account or report of a past or presently occurring event, situation or state of affairs. Teacher describes an object by stating its attributes, functions, structure, uses, etc. A statement need not be an isolated bit of information to be coded in this category. Teachers may state generalizations as important information to be memorized by pupils. Teachers give factual information in many ways, such as the following:

1) Teacher states what happened or is happening, e.g., millions of people died (or are dying) from malaria; the green plant gives off oxygen.

2) Teacher states what was done or is being done, e.g., Robert Hooke looked at a piece of cork under the microscope; scientists are trying to find what causes cancer.

3) Teacher states the functions, purposes, uses, structure, shape, composition, properties or attributes, location of an object, e.g., the function (purpose) of the cilia is to help the paramecium to move; the cilia are used for locomotion in the paramecium; the long bones are made up of marrow, blood vessels, bony layer...; another property of the arteries is that they are quite elastic; the cells of the epidermis are brick shaped; the adrenal glands are located above the kidneys.

4) Teacher states numerical values, how many, how much, what size, etc., of some object, e.g., your body contains about 12 pints of blood; the heart beats about 70 times per minute; the heart is about the size of your fist; bacteria divide about every 30 minutes.

5) Teacher makes statements regarding the existence (or lack) or an object, etc., e.g., the Dodo bird is extinct; kangaroos are found in Australia; the nerve endings for touch are located close to the surface of the skin.

6) Teacher states something that the pupils have experienced, e.g., you saw the three-chambered heart when you dissected a frog.

7) Teacher states the observations, data, result of an experiment, laboratory or class activity, or demonstration.

Sub-Category 6X. Teacher Explains, Makes Inferences, Makes Comparisons, States Relationships between Objects, Events, Generalizations. Teachers explain in many ways such as the following:

1) Teacher states the relationship between antecedent and consequent, or cause and effect, and makes inferences, e.g., due to an over secretion of the thyroid hormone, the metabolism is speeded up and...; if the diet is deficient in Vitamin A, then...; the nucleus appears darker because it absorbs more iodine than the rest of the cell. Verbal cues, such as because, due to, therefore, the reason, since, if... then, are very useful in identifying explanations and inferences.

2) Teacher shows relationship by explicitly comparing and contrasting, i.e., by stating the similarities and differences, e.g., the heart of amphibians is three-chambered, whereas that of mammals is four-chambered. Verbal cues, such as differ, compare, correspond, like, similar, common, are useful in identifying comparisons.

3) Teacher states the relationship between or among events, functions, objects, concepts, generalizations, e.g., as the left ventricle contracts, the aortic valve opens and...; as the oxygen supply decreases the number of anaerobic bacteria begins to increase...; the function of the left ventricle is to pump blood to the body, and so you would expect the muscles to be thicker than....

4) Teacher gives justification or states reasons for an opinion, evaluation, laboratory precaution, e.g., the stomach is not as important an organ as one may think because one can survive even when it is removed; the pituitary is probably the most important endocrine gland because it has an effect on so many other glands.

5) Teacher states the steps in a process or procedure, such as cell division, digestion, breathing, removal of oxygen from the blood. Subcategory 6X rather than 6F is used, since the individual steps are not isolated bits of information, but are interconnected and often follow a certain sequence as indicated by verbal cues, such as: to start with, first, next, then, from there it goes to. Note that though laboratory directions often include procedural explanations, the directions are coded as category seven and not 6X.

Sub-Category 6E. Teacher Evaluates, Makes Value Judgment, Gives Opinions about the Subject Matter. The teacher gives an evaluation or opinions regarding the importance, value of an object, biological function, attribute, process, event, generalization, e.g., the stomach is not as important or necessary as one may think; I think that both heredity and environment are important in determining the personality; the process of mutation is important in producing variations. Recall that justification or reason for the evaluation or opinion would be categorized as 6X. Note: This sub-category does not include evaluation of pupil's responses and behavior or misbehavior.

Sub-Category 6N. Teacher Gives Information about the Nature of Science. A universally acceptable, definitive statement about "The Nature of Science" is not possible. "Information about the Nature of Science" will be used in a broad general sense to include statements about science as organized knowledge and as processes of inquiry.

The teacher gives information about:
1) the inter-relatedness of scientific knowledge and scientific disciplines;
2) the processes and role (in science) of observation, inference, classification, verification, analysis, speculation, prediction, experimentation, communication, generalization, conceptual schemes, theories, principles, laws, hypotheses, etc.
3) scientific attitudes, such as objectivity, open-mindedness, belief in cause and effect, curiosity, patience, dedication, etc.

Sub-Category 6L. Teacher Makes Statements about Lack of Information and Limitation of Knowledge. Teacher states that he doesn't know, he is not sure, he will "look up" the information, or that probably scientists do not know. For example, after looking at some object on a pupil's slide the teacher may say: I don't know what that is.

Category 7. Teacher Gives Laboratory and Substantive Instructions or Directions. Teacher gives laboratory directions or instructions; states steps to be followed in solving a problem or setting up the apparatus or carrying out an experiment or demonstration or lab exercise. Tells pupils what chemicals or equipment to use, tells pupils to look for certain structures of an organism, or to look for certain characteristics, such as shape, color, size, or to look for changes in characteristics, etc. Sometimes directions may be worded as if they were suggestions, e.g., you may try using some iodine to stain the nucleus...you may use either Benedict solution or Fehling solution. Definitions, facts, explanations, questions, etc., interspersed with directions should not be placed in category 7, but in the appropriate category.

Two sub-categories of Category 7 are as follows:

Sub-Category 7C. Teacher States Precautions or Requires Strict Adherence to certain steps in the procedure to be followed, e.g., be careful with the acid; make sure that you sterilize the inoculating needle before touching the culture.

Sub-Category 7S. Teacher Suggests or Allows Alternative or New Approaches to an Experiment, Activity or Problem. The teacher suggests an extension of the class or laboratory work. The pupil is encouraged to explore some interesting possibilities over and beyond the "required" work. Also included in this category are statements that permit or encourage pupil(s) to follow up ideas initiated by the pupil(s). The pupil is not given detailed directions to follow and the outcome of experiment or activity is not known to the pupil and possibly the teacher. The work would be voluntarily undertaken by the pupil. The suggestion may be couched in question form or stated explicitly as a choice, e.g., I wonder what would happen if...; I don't know whether it would work or not, how about trying it out...?

This category should not be used in cases where, although alternatives are given, the student has little or no choice or opportunity to exercise initiative or solve a problem, e.g., you may use either Benedict's solution or Fehling's solution.

Category 8. Teacher Asks Questions Regarding Subject Matter. This category includes questions about the subject matter only. Rhetorical questions, directives and reprimands phrased as questions, and questions about classroom routines are placed in other categories. Where applicable the following sub-categories are used: 8D, 8F, 8X, 8E, 8N, 8L, 8P. The designation 8U is used if the question (about subject matter) cannot be classified in the sub-categories.

Sub-Category 8D. Teacher Asks Pupil to Define Terms, Give Examples of the Term, Give Meaning of Words, Phrases, Sentences, Give the Name of a Process, Object, Event, Generalization. (See 6D also.) Teachers ask for definitions, etc., in many ways.
1) By asking for one or more examples of the term, e.g., give me an example of a legume; What's another one?
2) By pointing to an object, model, diagram, picture, etc., and asking the name of the referent, e.g., What is this thing or structure called?
3) By asking for synonyms, symbols, etc., e.g., What's another word for cane sugar? What is the symbol for Carbon? What does DNA stand for?
4) By giving the genus or class term and asking for the differentia; e.g., What is an artery? or by giving the differentia and asking for the genus, e.g., Blood vessels that carry blood to the heart are called what, John?

In cases where it is not clear whether the teacher is asking for a definition or for a description or fact, contextual clues and the teacher's response to the pupil's answer need to be used.

Sub-Category 8F. Teacher Asks Pupil to State Facts, Describe, Give an Account or Report of an Event. Teacher asks pupil to state facts or items of information without explanations, to give an account or report of a past or presently occurring event, situation or state of affairs. Teacher asks pupil to describe an object by stating its attributes, functions, structure, uses, etc. Teacher asks pupil to recite or recall a generalization. Teacher asks pupil to state what steps of the laboratory experiment have been taken, what data and results have been obtained, e.g., What happened when you added the solution? Did you get a 3:1 ratio? What did you add to the egg white? Contextual clues are used to decide whether the teacher is asking the pupil to state or recite or describe what he has done or the results he has obtained or whether the teacher is asking for an explanation. (See 6F and 6X.)

Sub-Category 8X. Teacher Asks Pupil to Explain, to Make Inferences, to Compare and Contrast, to State Relationships between Objects, Events, Processes, Generalizations (See 6X also.) Teachers may ask pupils to give a full or complete explanation by asking for antecedents and consequents, e.g., explain how the rate of breathing is controlled; explain how we breathe. Teachers may "give" the antecedents, and ask the pupil to give consequents or vice-versa. Frequently, the pupil is asked to (or need only) give a word or phrase to complete the explanation; As the carbon dioxide content of the blood increases, the rate of breathing does what? Teacher asks pupil to explain why he carried out certain operations in an experiment, lab or class activity, or why he got certain results or to predict consequences, e.g., Why did you add iodine to the onion cells? Why did the cells burst? What would happen if you put the cells in distilled water? Teacher asks pupil to explain processes, to give reasons or justification for opinion or evaluation, etc.

Sub-Category 8E. Teacher Asks Pupil to Evaluate or Make Value Judgements, to Give Opinion. (See 6E also.) This category is restricted to evaluation and opinions regarding the importance, necessity, value, etc. of an object, function, process, attribute, event, etc. (not classroom behavior but rather the subject matter) e.g., What is the most important function carried out by the liver? What kind of fertilization is better, external or internal?

Sub-Category 8N. Teacher Asks Pupil to Give Information about the Nature of Science. (See 6N also.) Teacher asks pupil to give information about inter-relatedness of scientific knowledge, the processes of science, scientific attitudes, etc.

Sub-Category 8P. Teacher Asks Pupil about Problem Solving Procedures, Techniques, Steps to be taken to carry out lab activity or experiment or to solve a problem presently or in the future. Teacher asks pupil to state, describe, explain, how he would carry out an experiment or activity for which the teacher has not given directions. The experiment or activity or problem represents an extension of the class or lab work and is not required work, e.g., How would you go about finding out the effect of...? How would you set up an experiment to find out...? This category does not include questions asking a pupil to state or explain what steps of the lab directions (given by the teachers) have been carried out or how he has or will carry out the directions.

Category 9. Teacher Examines, Looks at, or Checks Pupil's Work. Teacher looks at pupil's slide under a microscope, dissection, "set up" of apparatus or other product of activity. Teacher quickly reads or checks a pupil's drawing, data, results, seat work, etc; e.g., I see the nucleus; I don't see an amoeba; I see a white blood cell on the far left; I can't find any dividing cells. The teacher may look at pupil's seat work, lab work, results, etc., either on his own initiative or in response to a question or request by a pupil.

Category 10. Teacher Asks Questions regarding Class Routines, Activities, Assignments, Procedures, Materials. In this category are included all questions related to the management of the classroom and laboratory, e.g., How many of you need more time to finish? Did you find the inoculating loop? How many people need review books? When did you have study hall? Do you understand? Is everything o.k.? How's it coming? Any questions? Did we finish the circulatory system on Friday? Did you finish already? Do you have your homework?

Category 11. Teacher Gives Routing Directives, Gives Assignments, Gives Procedural Orientation, Explicates Transition of Topics. Teacher calls class to order, excuses or dismisses the class, tells pupils to read, write, draw diagrams, to hand in work, to take out or put away books and equipment, to clean up the equipment, to put things in order. Teacher gives an assignment with or without suggestions about how to study, what to look for, etc. Announces quizzes and tests, tells what will be covered, how long test will last, how much the test will count. Teacher announces the "results" of tests, quizzes, assignments, makes comments regarding classwork, homework, tests, etc. Teacher tells pupils to be careful, neat, hurry up, to use ink. Teacher places the day's work in context, tells relationship with other topics of the courses, gives rationale, reasons for study of the specific topic or subject, explicates transitions, asks students to pay special attention to some aspect of an assignment, or chapter, or discussion, or question or statement, gives scope and limitation of a topic, assignment, provides framework or explicates frame of reference, gives cues that focus students' attention to particular aspects of the subject matter. Teacher tells pupils how teacher is going to present the material, e.g., in general terms, briefly, as an introduction to more detailed study, as details of a prior general statement, etc. Teacher tells pupils how present topic or knowledge is related to past or future subject matter. Teacher tells pupils certain topic will be covered later, etc. Teacher tells pupils that he is returning to a topic previously studied. Teacher tells pupils the reason for doing something a certain way, i.e. the rationale for class routines and procedures.

Category 12. Teacher attends to Routines and Class-Management, Takes Attendance, Distributes Materials, Prepares Materials, Performs Services. Teacher takes attendance silently or calls out pupils' names (pupils' response is not coded) distributes or collects papers, books, lab equipment and materials. Teacher prepares solutions, microscope slides, weighs material, sets up apparatus, sets up demonstration, takes care of aquaria, terraria, plants, animals, cleans up the classroom or lab. Teacher goes to shelf or stockroom or some other room to get materials. Teacher corrects papers, writes or reads at desk, looks up reference book notes, text, etc.

Category 13. Teacher Oversees Pupils at Work, Engages in Minimal Verbal Interaction. Teacher walks around the room or from one lab desk to another without stopping at any desk for longer than 4 or 5 seconds. Teacher sits or stands silently at desk or some part of the room looking at the class as a whole. He is not specifically examining any student's work at a desk but rather overseeing the work of the students. As a result of this activity he may observe one or more students doing something which may necessitate some other kind of interaction.

If the teacher stops at a desk for longer than 4 or 5 seconds and examines or looks at pupils' work use category 9. If the teacher is walking around getting or distributing materials, cleaning up or engaged in routine tasks use category 12.

Category 14. Pupil Asks for Information and Assistance. In this category are included all questions asked by pupils. Wherever applicable the following sub-categories are used, viz., 14D, 14F, 14X, 14E, 14N, 14A. The designation 14U is used if the question cannot be classified in the relevant sub-category.

Sub-category 14D. Pupil Asks for Definitions, Examples of Terms, Meaning of Words, Phrases, Sentences, Name of a Process, Object, Event.

Sub-category 14F. Pupil Asks for Facts, Description, Account or Report of Event.

Sub-category 14X. Pupil Asks for Explanation, Inference, Comparison, Relationship between Objects, Events, Processes, Generalizations.

Sub-category 14E. Pupil Asks for Evaluation or Value Judgment, Opinion about the Subject Matter.

Sub-category 14N. Pupil Asks for Information about the Nature of Science.

The criteria and examples already mentioned under category eight are applicable and need not be repeated. Note: It is often difficult to hear clearly and fully what the pupil is saying. Often the observer has to rely on fragments of a question, or repetition of the question by the teacher and sometimes infer the type of question from the response of the teacher. An important clue to remember is that the pupil is seeking substantive information of the kind mentioned under category six. Though questions are addressed most frequently to the teacher, the above sub-categories are used for questions directed to other pupils also, but only when they are asked in the course of a discussion and are permitted by the teacher. Whispered questions to pupils seated near-by are not categorized.

Sub-category 14A. Pupil Asks about Laboratory Directions, Techniques, Procedures, Materials, Classroom Routines. This category includes a major portion of questions asked in the laboratory and a relatively minor portion of questions asked in the lecture-discussion classes. Broadly speaking, questions included in this sub-category solicit assistance from the teacher in many ways. Though these questions are not further sub-divided they will be grouped in the following examples:

1) Pupils ask for and about laboratory directions and techniques, i.e., the kind of directions included in category seven and sometimes requiring a demonstration, e.g., How much Fehling's solution do I add? How do I know when to stop heating? How does the bunsen burner work? What should I use to stain this slide? How many test tubes do I need?

2) Pupils ask for materials and services, i.e., they solicit teacher behavior included in category twelve, e.g., Where is the Fehling's solution? I need some test tubes. Where is the book?
3) Pupil asks for confirmation or verification, asks if his laboratory work or seat work is correct, right, whether it is what he is supposed to be doing, i.e., soliciting the kind of response included in categories two and three, e.g., Are those things in the center the chromosomes? Is this slide OK? Is this the color we should get? Is this blue-black?
4) Pupil asks about classroom or laboratory routines, procedures, assignments, quizzes, etc., i.e., the kind of directives included under category eleven, e.g., When is our homework due? What did I get on the test? Where is the soap? Where do I put the slides?

Category 15. Pupil Gives Information or Responds. In this category are included pupil responses to questions asked by the teacher or another pupil as well as "voluntary" information given by the pupil. Note that the response may be just a word or two or a few sentences. Wherever applicable the following sub-categories are used, viz., 15D, 15F, 15X, 15E, 15N, 15L, 15P, 15R. The designation 15U is used if the "information" cannot be classified in the relevant sub-category.

Sub-category 15D. Pupil Defines Terms, Gives Examples of Terms, Process, Object, Event, Generalization, etc.

Sub-category 15F. Pupil States Facts, Describes, Gives an Account or Report of an Event.

Sub-category 15X. Pupil Explains, Makes Inferences, Makes Comparisons, States Relationships between Objects, Events, Generalizations.

Sub-category 15E. Pupil Evaluates, Makes Value Judgment, Gives Opinion about the Subject Matter.

Sub-category 15N. Pupil Gives Information about the Nature of Science.

Sub-category 15L. Pupil Makes Statements about Lack of Information and Limitation of Knowledge.
The criteria and examples mentioned under category six are applicable and need not be repeated.

Sub-category 15P. Pupil Proposes the Procedures, Techniques or Steps to carry out lab activity or experiment or to solve a problem presently or in the future. In this category are included only those statements which are proposed by the pupil. A recitation of definitions, facts, explanations regarding teacher-given lab directions or problem-solving procedures should be coded as 15D, 15F, 15X, etc. The statements in Category 15P would be called for by the questions in subcategory 8P, e.g., in order to find out the effect of temperature on the heart beat I would...; I would set up an experiment in which...

Sub-category 15R. Pupil Gives Information regarding Routines, Classroom Procedures and Activities, Assignments, Materials. Responses in this category usually consist of a yes or no or raising of hands, phrase or a short phrase. The pupils' responses are usually solicited by questions in category ten.

Category 16. Silence. In this category are included only pauses and short periods of silence occurring after a question has been asked, a directive or a reprimand has been given, or in the middle of a sentence as teacher or pupil gropes for words or pauses to think. The silence must be at least four seconds in duration. However, in this category do not include periods of silence longer than 30 seconds encountered while pupils are reading silently or writing or carrying out laboratory activities, use the appropriate teacher behavior category, such as nine, twelve or thirteen.

Category 17. Not Categorizable in Above System. In this category are included only those statements or behaviors which cannot be classified into any of the above categories according to the criteria and definitions of this system. Wherever possible a notation should be made in the margin to indicate the behavior categorized as "17."

Ground Rules for Categorizing Teacher-Pupil Interaction

Teacher-pupil interaction is bewilderingly complex, and there is a limitless variety of nuances and gradations. A category system is after all an artificial classification scheme and the compartmentalization of the fluid, complex, process of human interaction into mutually exclusive categories is achieved by the use of more or less arbitrary "cut-off points." The aforementioned categorization and the definitions of categories should enable an observer to use the category system with a fairly high degree of reliability.

However, many problems in coding arise due to a number of factors, such as the following: inaudibility and indistinguishability of words, phrases or sentences, ambiguity, vagueness, unique stylistic devices, rapid interaction, confusion due to two or more persons talking at the same time, simultaneous occurrence of verbal and non-verbal behavior classifiable in separate categories, changes in the middle of a sentence, incomplete sentences and conflicting cues within a single sentence. It would be impractical, if not impossible, to list rules to cover every eventuality and a trained observer has to use his best judgment. However, in order to increase the objectivity of the category system, certain (arbitrary) ground rules covering the more commonly occurring problematical situations are given below:

1. Two or more persons are talking at the same time

    a) If the teacher and one or more pupils talk simultaneously, categorize the teacher's speech. (The emphasis or focus in the category system is on teacher behavior.)

    b) If two or more pupils talk simultaneously (while teacher is silent), categorize the speech of the pupil who was or is "recognized" or "acknowledged" by the teacher.

2. Verbal and non-verbal behavior categorizable in two categories occurs at exactly the same time.

    a) Categorize only the verbal behavior when the non-verbal behavior is of a routine nature (category 12 and 13), for example, the teacher gives directions, gives information, asks questions, praises, reprimands, etc., while distributing materials such as laboratory supplies, papers, books; erasing the chalkboard, "setting up" a projector, etc.

    b) Categorize both verbal and non-verbal behavior when the non-verbal behavior (category 5 or 9) is in the Cognitive Dimension.

        i) Teacher gives a demonstration (category 5) and talks at exactly the same time. This situation has been observed very infrequently, usually statements or questions precede, follow, or are interspersed with various non-verbal actions constituting the "demonstration." In the rare cases of simultaneous occurrence, one pair of category numbers is written every five seconds (or sooner in case of a category shift), e.g., 5, 7, 5, 7, 5, 6X, 5, 6X, 5, 8F, 5, 8F, 5, 11, etc.

ii) Teacher looks at a pupil's work (category 9) and talks at exactly the same time; one pair of category numbers is written every five seconds, e.g., 9, 2, 9, 3, 9, 8F, etc.

3. Observer is uncertain as to which major category to use.

   a) Categories 1 versus 2, 2 versus 3, 3 versus 4. The absence of certain cues and subtle shifts from one category to another may make coding difficult. In such cases the order of preference is 1, 2 and 3 respectively.

   b) Categories 6 versus 11, 7 versus 11, 9 versus 13. Primarily due to subtle shifts within these pairs of categories uncertainty may result as to whether a shift or change has indeed occurred. In such cases the observer should continue with the prevalent category until he is certain the shift has occurred. However, the observer must be alert to such shifts and change categories when definite shifts do occur even if the shifts occur only momentarily.

   c) Categories 14 versus 15. "Pupil-Talk" is often inaudible or indistinguishable, but (fortunately) teachers often repeat a part or all of a pupil's utterance or give some other response thereby providing clues that aid in classification. If such clues are not available use category 14.

4. Observer is uncertain as to which sub-category within the major categories 6, 8, 14 and 15 should be used. Sometimes the observer is unable to decide at the end of 5, 10 or 15 seconds as to which sub-category to use. In such cases the observer writes the number of the major category alone, and then, if subsequent talk provides the necessary clues, adds the sub-category designation. If at the end of about 15 seconds the observer still cannot decide which sub-category to use, 6U, 8U, 14U or 15U is used as the case may be. The observer should attempt to minimize the frequency with which he uses the 6U, 8U, etc. (Frequent use of 6U, 8U, etc. by a "new" observer may be due to insufficient training and further training may be necessary).

5. When teacher writes on the board, categorize as if he were speaking. When teacher draws a diagram, assume that he is describing something and categorize as 6F, but categorize the labels as 6D, explanatory comments as 6X, and evaluative comments as 6E.

6. When the teacher gives an "oral quiz" and the pupils write down the answer, categorize the teacher's talk into the appropriate sub-categories, and then, while the teacher is silent and the pupils write, assume that most of the pupils are responding appropriately to the type of question asked and use the corresponding sub-category of pupil response, e.g., teacher asks for definition--pupils write (give) definition, and hence should be coded 8D, 8D, 8D, 15D, 15D. (Note: The numbers are written every five seconds as usual.)

APPENDIX B

A CATEGORY SYSTEM FOR THE CLASSIFICATION OF VERBAL BEHAVIOR OF PUPILS IN BIOLOGY CLASSES

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A CATEGORY SYSTEM FOR THE CLASSIFICATION OF VERBAL BEHAVIOR OF PUPILS IN BIOLOGY CLASSES

Description of the System

The category system described herein consists of 36 mutually exclusive categories for classification of pupil participation or more accurately the verbal behavior of each pupil in high school biology lecture-recitation-discussion classes. All utterances by pupils addressed to the teacher and those pupil-utterances addressed to other pupils in connection with the ongoing class work are included. Private conversations, asides, whisperings, socializing, etc., are not included. Non-verbal behavior is not included and it is assumed that, in lecture-recitation-discussion types of classes, the verbal behavior is an adequate representative sample of pupil behavior.

The Verbal Pupil-Behavior Category System (VPBCS) is based on the same theoretical foundation as the Parakh Category System for Classification of Teacher-Pupil Interaction in High School Biology Classes. The VPBCS can be used independently or as a supplement to the Teacher-Pupil Interaction System. Pupil classroom behavior is conceptualized as Information-Seeking (Asking Questions) and Information-Giving. Information-Giving is viewed as taking place in three major ways, depending on the degree of initiative or independence or autonomy exercised by the pupil, namely, making Self-Initiated Statements or Utterances, Responding Voluntarily and Replying when specifically addressed or called upon. Thus there are four major ways or modes of pupil verbal behavior each symbolized by a letter of the alphabet: Questioning (Q), Making Self-Initiated Statements or Utterances (S), Volunteering (V) and Replying (R).

Each of the four MODES of pupil-talk was sub-divided into the nine KINDS of utterances identified in the Parakh Teacher-Pupil Interaction System as: Defining (D), Fact-Stating (F), Explaining (X), Evaluating Subject Matter (E), Explicitly referring to the Nature of Science (N), Stating Lack of Knowledge or Information (L), Verbalizing Problem-Solving Procedures (P), Dealing with Classroom Routines (R), and Utterances Unclassifiable in the above eight kinds (U). The first seven kinds of utterances are substantive in nature and the eighth kind (R) refers to classroom procedures and management, assignments, etc. These eight sub-divisions almost completely exhaust the various kinds of pupil utterances usually heard in biology classes. However, there may be occasional humorous remarks and other utterances that are unclassifiable in the first eight kinds and are represented by U. Parenthetically, the sub-division U can also serve as an empirical check of the exhaustiveness of the other eight sub-divisions.

By combining the four modes of pupil participation with nine kinds of utterances a total of 36 mutually exclusive categories are formed. Each such category is symbolized by a combination of two letters of the alphabet, the first letter referring to one of the four modes (Q, S, V, R) and the second letter referring to one of the nine kinds of utterances (D, F, X, E, N, L, P, R, U) as follows:

QD	QF	QX	QE	QN	QL	QP	QR	QU
SD	SF	SX	SE	SN	SL	SP	SR	SU
VD	VF	VX	VE	VN	VL	VP	VR	VU
RD	RF	RX	RE	RN	RL	RP	RR	RU

OUTLINE OF CATEGORIES OF VERBAL BEHAVIOR OF PUPILS IN BIOLOGY CLASSES

PUPIL SEEKS INFORMATION

Q	Pupil (P) Asks Questions or asks for information. Rhetorical questions are not considered as questions but as information-giving utterances
QD	P Asks Teacher or Another Pupil to Define Terms, Give Examples of Terms
QF	P Asks Teacher or Another Pupil to State Facts, Describe, Give an Account or Report of an Event
QX	P Asks Teacher or Another Pupil to Explain, Make Inferences, Make Comparisons, State Relationships between Objects, Events, Generalizations
QE	P Asks Teacher or Another Pupil to Evaluate, Make Value Judgement, Give Opinions about the Subject Matter
QN	P Asks Teacher or Another Pupil to Give Information About the Nature of Science
QL	P Asks about the Lack of Information and/or Limitation of Knowledge
QP	P Asks about Problem Solving Procedures, Techniques, Steps to be taken to carry out an experiment or to solve a problem that grows out of, or is an extension of the "required" work
QR	P Asks about Class Routines, Assignments, Classroom Procedures, Rules, Materials, Assistance, Repitition of an Utterance
QU	P Asks Questions Unclassifiable in above

PUPIL GIVES INFORMATION

S	Pupil Makes a Self-Initiated Statement or utterance other than a question -- Pupil is not responding to a question or directive but is speaking independently or autonomously
SD, SF, SX, SE, SN, SL, SP, SR, SU	-- Pupil gives Definitions, Facts, Explanations, etc. as defined above under Q
V	P Voluntarily Responds to a question or utterance by the teacher or another pupil not specifically addressed to P (the pupil who responds)
VD, VF, VX, VE, VN, VL, VP, VR, VU	-- P Voluntarily give Definitions, Facts, Explanations, etc. as defined under Q
R	P Replies to a question or utterance by the teacher or another pupil after being specifically called upon to do so by name or by a nod of the head or by pointing when P has not asked or requested or volunteered to speak
RD, RF, RX, RE, RN, RL, RP, RR, RU	-- P Replies by giving Definitions, Facts, Explanations, etc. as defined under Q

Note: Detailed definitions and examples of the nine kinds of utterances (D, F, X, E, N, L, P, R, U) are given in the section entitled "Definition of Categories" under the Parakh Teacher-Pupil Interaction System and will not be repeated here. Definitions of the four modes of participation are given in the next section.

Definitions of Modes of Participation

The four modes of participation can be usually distinguished quite early by classroom observers and do not require detailed definition. However, a few criteria for discriminating among the four modes may aid in increasing agreement among observers.

Questions are inquiries or requests for information. Rhetorical questions do not solicit information and hence are not considered as questions but as information-giving utterances. On the other hand, a pupil may make an utterance such as: Cane sugar is sucrose, or cane sugar is sucrose, right, with an inflection on the last word in each example and thus be asking for information (or feedback?). In short, grammatical form alone cannot be relied upon in all cases and cues such as inflection of the voice are utilized.

Self-Initiated Statements. These are information-giving utterances. These utterances or statements (the word statement is not used in its strict logical sense but in contrast to questions which also entail self-initiated behavior) are made by pupils without any solicitation or request or command by the teacher or another pupil. Self-initiated statements may be made by interrupting or breaking in during a pause in the discourse or may be made after raising a hand and receiving permission to speak.

Voluntary Responses. These are information-giving utterances which are made in response to a solicitation for information or a question or directive by the teacher or another pupil. The teacher or questioner usually asks a question that is not directed to a particular pupil but rather to the class as a whole. Following such a question or directive by the teacher a pupil may speak without raising his hand (asking for permission) or he may raise his hand, receive permission by name or gesture, and then speak.

Replies. These are information-giving responses by a pupil to a question or command specifically directed to him by name or gesture when the pupil has not requested or volunteered to speak. The teacher or another pupil may indicate who is to respond before stating the question or after stating the question.

At the risk of being redundant certain similarities and differences among the four modes will be described. Asking Questions and Making Self-Initiated Statements are both self-initiated or independent of a solicitation by the teacher or another pupil and are not responses to a solicitation. But questions seek information and Self-Initiated Statements give information. Voluntary Responses and Replies are responses to a solicitation. A Voluntary Response does entail some initiative and choice on the part of the responding pupil but when a pupil is specifically called upon to Reply there is little left for him to do but Reply. The "Reply" in some cases may be nothing more than a mumbled "I don't know" or a shake of the head or a "looking down" at the desk or page in front of him -- such behaviors are considered as and further replies are taken as effective admission of a Lack of Knowledge and are classified as RL.

Procedure for Categorizing Verbal Behavior of Individual Pupils

1. Seating charts with names of pupils should be prepared prior to the observation.

2. The observer should be seated and ready to start coding before the class begins. By prior arrangement with the teacher the observer should select a seat in the back or at the side of the room such that the observer is as unobtrusive as possible yet still in a position to clearly see and hear the classroom discourse.

3. The observer starts categorizing pupil talk (usually addressed to the teacher) after the bell or buzzer sounds or the teacher starts the class whichever comes first, and continues categorizing until the teacher dismisses or excuses the class or the class leaves at the sound of the buzzer or bell.

4. On every occasion that a pupil speaks the observer writes the appropriate category symbol in the appropriate space on the seating chart. In addition the sequence of pupil utterances can be recorded by using numerical subscripts along with the symbol for the category of behavior observed. For example, the code VD_5 in a particular space on the seating chart would mean that the particular pupil had voluntarily given a definition and that this was the fifth pupil-utterance during that class period (See Table B-1).

5. Each pupil "speech" or pupil's talk on a given occasion when he has the "floor" or speaks without interruption is usually categorizable within a single category. Usually a pupil will give a single definition or fact or reason lasting five seconds or less rather than a number of definitions, facts, etc. in one speech. If within a speech a pupil sequentially uses more than one mode and/or kind of utterance, i.e., more than one category, then each change of category must be coded. For example, the notations VF_{31}. QX_{32} would signify that the pupil had voluntarily given a fact and then asked for an explanation.

6. To keep a record of the duration of a particular utterance, (in those few instances when a pupil utterance lasts longer than five seconds) the observer writes the same category number and subscript once every five seconds and then draws a line or bar over these notations. For example, $\overline{VX_{12}\ VX_{12}}$ $\overline{VX_{12}}$ would signify that the pupil volunteered an explanation that lasted about fifteen seconds.

7. The observer should watch the teacher as well as the pupils closely but unobtrusively in order to see a number of non-verbal cues, such as a raised hand or the orientation of the head or movement of the lips or cheeks, or to hear the tone of voice. These cues are helpful in deciding which mode of participation is being used and who is speaking.

TABLE B-1 SAMPLE OBSERVATION RECORD OF PUPIL PARTICIPATION IN A BIOLOGY LECTURE-DISCUSSION PERIOD [a]

Teacher Number ______ Period ______ Date ______ Time ______

$VX_{12}VX_{51}$	$\underline{VX_{5}RX_{42}}$ $VX_{52}VX_{52}$	$VF_{8}VX_{13}RF_{20}$ $VX_{21}SF_{22}VX_{23}$ $VF_{29}QE_{36}$	VF_{11} $\overline{VX_{30}VX_{30}VX_{30}}$		$VX_{17}RX_{18}SX_{19}$ $RD_{31}VD_{35}SF_{40}$ SX_{55}
$VF_{2}VX_{60}$		$QX_{39}VX_{49}$ VX_{61}	SF_{41}	$VD_{33}\overline{SX_{43}}$ $\overline{SX_{43}}SX_{45}$ SX_{46}	$VF_{1}SX_{26}SX_{27}$ $SX_{47}SX_{48}$ $VF_{56}VX_{57}$
$VF_{3}RX_{4}QX_{66}$	$VF_{6}VF_{7}VX_{10}$		VF_{9}	$RX_{15}RX_{16}$ RX_{24}	
			$\overline{VX_{32}VX_{32}}$ $VX_{34}VD_{35}$ VX_{50}		
VX_{54} Unidentifiable Speaker U.			$VF_{7}VF_{28}VE_{37}VE_{38}VX_{44}VF_{53}VF_{58}$ Group Responses G.		

3

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[a] Pupil names and teacher identification are omitted to preserve anonymity.

8. Non-verbal behavior is not coded on the seating chart. For example, if following a teacher's question a number of pupils have raised their hands requesting permission to speak and the teacher calls or selects one of them and the pupil speaks then his utterance is coded and the other pupils are not considered to have given a verbal response (even though they apparently wanted to respond). Possibly, this is a shortcoming in the procedure but it is extremely difficult for one observer to correctly attribute a large number of raised and partially raised hands and also categorize the on-going discourse.

9. Certain kinds of talking between pupils, such as private conversation, whispering, "socializing", telling jokes, etc., are not considered as part of the "agenda" or domain of discourse in this system and are not coded.

10. The observer writes brief notes in the margin or on the reverse of the chart or on a separate sheet to record items of interest such as kind of classroom activity, demonstrations, seat work, distribution of materials, topics being discussed, duration of activities, etc.

11. The observer categorizes from the perspective of the "generalized other". The observed classroom communication is categorized according to the effect it has on the observer as he takes the role of the "generalized other". The observer should constantly guard against categorizing on the basis of his own prejudices and biases or inferences about the speaker's intentions and motives.

Reliability of the Verbal Pupil-Behavior Category System

An important feature of a category system is that it enables an observer to obtain objective information. Thus two or more observers categorizing the behavior in a classroom at the same time can obtain essentially the same data by following the "rules" of the observational system. The term reliability has a number of meanings and is used in this section to indicate inter-observer agreement. A percentage of agreement was calculated based on the formula developed by Osgood, Saporta and Nunnally (27) as follows:

$$\text{Percent agreement} = \frac{100 \times 2(ACO_{12})}{ACO_1 + ACO_2} \quad \text{where } ACO_1 \text{ and } ACO_2 =$$

total number of interaction units exacted by coders 1 and 2 respectively and ACO_{12} is the number of common interaction units extracted by both coders.

A graduate student in Science Education was trained by the writer. Upon completion of training the writer and the trained observer sat at opposite corners at the rear of a classroom and independently coded the pupil participation for two biology lecture-recitation-discussion periods per day for four days. There were fourteen students in one biology class and twenty-three in the other. Both classes were taught by the same teacher.

Tables B-2 and B-3 show the behavior scores or number of utterances attributed to each pupil by two observers in two biology classes. Scores and percent agreement are given for the four modes (QSVR) and total pupil talk. In view of the small number of utterances by most pupils in each of the modes the writer decided not to calculate percent agreement on the nine (or even the five more commonly observed) kinds of utterances into which each of the four modes is sub-divided.

Inspection of Table B-2 shows that percent agreement on the scores per pupil in the class of 14 students ranged from 67 to 100% for Questions, and Self-Initiated Statements, 50 to 100% for Voluntary Responses, 45 to 100% for Replies and 60 to 100% for Pupil-Talk (all utterances). The percent agreement on class totals for the four modes and pupil talk are about 75% for Self-Initiated Statements and Replies and almost 100% for Questions, Voluntary Responses and Pupil-Talk. Inspection of Table B-3 for the larger class of 23 pupils shows essentially similar distribution of values for percent agreement, albeit, there are a few lower values.

Since most of the scores are quite small (about 3 or 4 utterances per pupil in four lecture-discussion periods) percentages tend to give a somewhat unreal picture and visual comparison of the actual scores reveals that in actuality the two observers are in fairly close agree-

TABLE B-2 BEHAVIOR SCORES ATTRIBUTED TO EACH PUPIL BY TWO OBSERVERS A AND B IN A BIOLOGY CLASS OF 14 PUPILS [a]

	Questions			Self-Initiated			Voluntary Responses			Replies			Pupil-Talk		
Pupil No.	A	B	% Ag[b]	A	B	% Ag	A	B	% Ag	A	B	% Ag	A	B	% Ag
12	0	0	100	1	1	100	11	8	84	4	2	67	16	11	81
13	0	3	-	0	3	-	54	41	86	7	2	45	61	49	89
14	0	0	100	2	0	-	8	6	86	3	3	100	13	9	82
15	3	3	100	1	2	67	31	39	89	4	4	100	39	48	90
16	0	0	100	0	0	100	1	3	50	2	4	67	3	7	60
17	13	13	100	0	0	100	12	12	100	1	1	100	13	13	100
18	1	1	100	0	0	100	0	0	100	1	1	100	1	1	100
24	2	1	67	0	3	-	47	35	85	3	1	50	52	40	87
25	0	0	100	0	0	100	3	5	75	6	3	67	9	8	94
26	0	0	100	0	0	100	3	3	100	0	0	100	3	3	100
27	1	0	-	1	1	100	12	31	56	1	0	-	15	32	64
34	0	0	100	0	0	100	2	1	67	5	2	57	7	3	60
35	0	0	100	0	0	100	2	2	100	1	2	67	3	4	86
36	2	2	100	1	1	100	44	48	96	4	1	40	51	52	99
Unident.	0	0	100	0	0	100	11	7	78	0	0	100	11	7	78
Group	0	0	100	0	0	100	12	21	73	0	0	100	12	21	73
Total	22	23	100	6	11	75	253	262	98	42	26	76	309	308	100

[a] Scores under A and B are number of utterances in four lecture-discussion periods.

[b] % Agreement calculated according to formula of Osgood et. al. ( ) cited in text.

TABLE B-3 BEHAVIOR SCORES ATTRIBUTED TO EACH PUPIL BY TWO OBSERVERS A AND B IN A BIOLOGY CLASS OF 23 PUPILS a/

Pupil No.	Questions			Self-Initiated			Voluntary Responses			Replies			Pupil-Talk		
	A	B	% Ag b/	A	B	% Ag	A	B	% Ag	A	B	% Ag	A	B	% Ag
11	0	0	100	0	0	100	11	4	53	2	1	67	13	5	56
12	0	0	100	0	0	100	1	0	-	1	1	100	2	1	67
13	0	0	100	0	0	100	1	0	-	1	1	100	2	1	67
14	0	0	100	0	0	100	5	1	33	1	1	100	6	2	50
15	1	1	100	0	0	100	9	6	80	1	1	100	11	8	84
16	1	2	67	1	5	33	31	27	94	1	1	100	34	35	99
17	8	6	86	2	11	31	37	39	97	0	1	-	47	57	90
18	4	8	67	1	2	67	32	9	44	3	1	50	40	20	67
21	0	0	100	0	0	100	2	0	-	1	3	50	3	3	100
22	0	0	100	1	2	67	15	15	100	2	2	100	18	19	97
23	0	0	100	0	0	100	7	2	45	1	1	100	8	3	55
24	1	0	-	1	0	-	9	9	100	2	1	67	13	10	77
25	0	1	-	0	0	100	7	10	82	1	4	40	8	15	74
26	2	2	100	3	2	80	34	46	85	3	3	100	42	53	88
27	0	0	100	0	0	100	0	0	100	1	1	100	1	1	100
28	0	0	100	0	0	100	2	1	67	1	1	100	3	2	80
31	4	4	100	0	0	100	23	8	52	0	1	-	27	13	65
32	1	0	-	0	2	-	5	2	57	0	0	100	6	4	80
34	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
35	0	0	100	0	0	100	0	0	100	1	0	-	1	0	-
36	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
37	0	0	100	0	0	100	4	7	73	0	0	100	4	7	73
38	0	0	100	0	0	100	0	2	-	1	0	-	1	2	67
Unident.	0	0	100	0	0	100	5	11	63	0	0	100	5	13	56
Group	0	0	100	1	1	100	74	94	88	0	0	100	75	95	88
Total	22	24	96	10	25	57	314	293	97	24	25	98	370	369	100

a/ Scores are number of utterances in four lecture-discussion periods.

b/ % Agreement calculated according to formula of Osgood et. al. ( ) cited in text.

ment on the large majority of scores and confidence in the realiability of the system is justifiable.

However, the few large discrepancies between observers shown in Tables B-2 and B-3 do require a discussion of the major sources of discrepancy. The two observers carefully compared their observation records and found that most of the discrepancy was due to the location of the particular observer in relation to the pupil who was talking, especially if the pupil spoke so softly or indistinctly that only one of the two observers could barely hear the pupil. A second common source of discrepancy was found in cases where two "soft-spoken high participators" sat next to each other and the two observers attributed some of the utterances to different members of the paid.

In sum, it is the judgement of the writer that while sufficiently high levels of inter-observer agreement were reached a number of coding problems await solution for even higher levels of inter-observer agreement. Caution is advised in the interpretation of the data and possible applications of the findings.